EFFECTIVE DROUGHT MANAGEMENT FOR SUSTAINED LIVELIHOODS IN THE MIDDLE EAST

by

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Abstract

Drought has become a more frequent and a major threat to human security in most of the Arab countries located in arid and semi-arid areas of North Africa and Western Asia. The responses to severe drought in the region's countries are mainly ex-post (reactive) and tend to emphasize emergency relief, take effect after or during drought events and do not incorporate methods that support water conflict prevention. The United Nations recognizes the need to address water scarcity and drought in the Middle East so they began a new initiative to strengthen national capacities to manage drought and water scarcity this region. This project is an extension of the United Nations initiative and focuses on pre-impact and preparedness drought management planning in the Middle East. 10 pilot countries from the Middle East are involved in the project to provide critical information about the current drought management practices in their individual countries. The project is broken up into two separate sections: Section 1 is the analysis, mapping and identification of critical gaps in pre-impact and preparedness drought management in the Middle East, and Section 2 is a case study of drought management in Israel. For Section 1, responses from the pilot country representatives and a thorough literature review of successful drought management strategies in other arid regions of the world were used to determine opportunities for capacity building and pre-impact preparedness drought management strategies that could be used in the Middle East. Based on the literature review and interview responses from the pilot countries, results showed that Middle Eastern countries would benefit from adopting early warning systems, microfinance and index-based insurance, and longer-term drought management strategies that emphasized preparedness. For Section 2 of the project, the Israel case study, lessons learned from Section 1 and CIHEAM guidelines were applied to Israel to develop effective long-term, proactive drought management strategies for the country. CIHEAM is an intergovernmental organization trusted by the United Nations and is a leader in the fields of drought, agriculture and rural development. Some of the strategies most suitable for Israel include wastewater treatment and reuse, crop diversification and seawater and brackish water desalinization.

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Introduction

The West Asia North Africa region is one of the driest, most water-scarce regions of the world and is extremely sensitive to the effects of climate change. According to the Intergovernmental Panel on Climate Change (IPCC) The West Asia North Africa region is projected to become even hotter and drier in the future, experiencing a decrease in annual precipitation levels and increased temperatures. Results from IPCC Fourth Assessment Report (2007)[1] indicate that this region is expected to experience a 3.5-7 degree Centigrade temperature increase in the last 20 years of this century compared to the last 20 years of the twentieth century. Furthermore, the region is expected to see up to 50% less rain in the last 20 years of this century compared to the amount of precipitation seen in this region between 1980 and 1999. Severe cases of drought and water scarcity are already characteristic of the region, and with climate change IPCC projects that there will be an even more frequent and severe drought, water scarce conditions and increase in consecutive dry days (CDD)[2].

There is a need now more than ever to combat drought and water scarcity in the Middle East.

Currently the approaches to drought and water scarcity in the region are reactive and tend to emphasize emergency relief measures. This project is an extension of the United Nation's initiative to strengthen the national capacities to manage drought and water scarcity in the Asia North Africa Region with an emphasis on proactive and preparedness drought management. The objective of this project is to create an increased awareness and knowledge of tools and methodologies for national planners, policymakers, institutions and stakeholders in countries in transition settings in order to develop proactive drought management plans. The project will focus on the information and dissemination systems in the region, early warning systems and drought monitoring, and experience with microfinance and index-based insurance in the region. Other focuses include pre-impact and preparedness measures that have been proven successful, including the application of drought resistant agriculture, water resources conservation and management plans.

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[1] Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.). CambridgeUniversity Press, Cambridge, United Kingdom and New York, NY, USA.

[2] Adaptation to Climate Change in the Middle East and North Africa Region For. (2013). Retrieved from http://web.worldbank.org/WBSITE/EXTERNAL/COUNTRIES/MENAEXT/0%2C%2CcontentMDK%3A21596766~pagePK%3A146736~piPK%3A146830~theSitePK%3A256299%2C00.html

Ten pilot countries were heavily involved in this project. They played a key role in helping to answer important questions about drought management in their individual countries. These pilot countries included 3. High-level officials from these countries with strong affiliations to the ministries of water, environment and agriculture made up the country representatives. The strengths and weaknesses of their drought management plans, existing knowledge gaps, and opportunities for capacity building were addressed in this study and used to provide a framework to strengthen national capacities to manage drought in similar countries. The United Nations also relies heavily on Drought Management Guidelines provided by

International Centre for Advanced Mediterranean Agronomic Studies (CIHEAM). CIHEAM is an intergovernmental organization made up of four Mediterranean agronomic institutes. The UN Chose CIHEAM guidelines because it has established itself as an authority in the fields of agriculture, food and rural development.

This project is divided into two sections. The first section is the analysis, mapping and identification of critical gaps in pre-impact and preparedness drought management in the Middle East. The second section is a case study of Israel in which the CIHEAM guidelines and lessons learned from Section 1 are applied to the country in order to come up with specified, effective drought management strategies for the Israel.

Methods

Methods for Section 1:

Section 1 of this project is the analysis, mapping and identification of critical gaps in pre-impact and preparedness drought management in the Middle East. This section involved a thorough literature review of current successful drought management strategies in arid and semi-arid regions of the world. The research focused heavily on proactive and preparedness drought management strategies. During this phase of the project I worked alongside a team of civil engineers that worked onsite in Beirut, Lebanon and the Chief Sustainability Officer at the United Nations Department of Economic and Social Affairs. The following methods were used in order to determine existing knowledge gaps and opportunities for capacity development for effective and proactive drought management in Middle Eastern Countries:

1. Conducted surveys and interviews from representatives from pilot countries in order to determine existing resources and capacities in drought management
2. Conducted a literature review to determine best methods for proactive drought management based on success in other countries
3. Analyzed resource and capacity gaps based on country responses and literature review findings
4. Proposed proactive drought management strategies to make up for gaps in capacity determined from literature reviews and pilot country interviews.

Methods for Section 2:

Section two is the case study of drought management in Israel. CIHEAM Drought Management Guidelines and lessons learned from Section 1 were applied to Israel in order to come up with effective drought management strategies for the nation. The information collected from Israel in order to determine best drought management strategies for the nation included water resource information, key stakeholders, legal frameworks and drought policies, institutional frameworks, key vulnerabilities to drought and currently available technology to combat drought, as outlined in the CIHEAM guidelines. A drought vulnerability index was used in order to determine the areas in which Israel was most vulnerable to drought. The areas that were revealed to be most vulnerable to drought by the drought vulnerability index were focused on in the recommended drought management strategies. The management options proposed were long-term measures that emphasized being proactive and suitable for Israel's geographic, economic and political settings. The methods below describe the methods used for Section 2 of this study, the Israel Case Study:

1. Applied lessons learned from Section 1 to the Israel case study
2. Applied CIHEAM guidelines to Israel to assess planning framework and purpose, legal and institutional frameworks
3. Used drought vulnerability index to determine areas where Israel is most vulnerable to drought
4. Proposed drought management strategies for the country based on information gathered from guideline principles and Section 1

Section 1: The Analysis, Mapping and Identification of Critical Gaps in Pre-Impact and Preparedness Drought Management in the Middle East

Need for National Action and Drought Mitigation Strategy

The Centre for Research on the Epidemiology of Disasters has an emergency events database (EM-DAT),[3] which includes statistics of the number of people killed or affected by natural disasters around the world. According to the published figures, 1 and 2, the distribution of the population affected by drought alone is 51% compared to 49% of all other disasters combined. This fact illustrates the severity of the issue of drought. It is also clear that the Middle East and Asia region is the most affected region in the world, being that 83% of the population in this area is affected by drought.

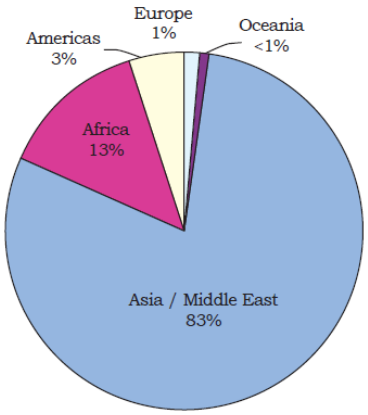


Figure 1: Figure 1: Distribution of population affected by drought between 1990 to 2004 (Below, 2007)[4]

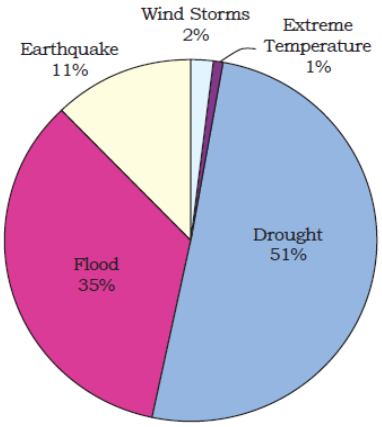


Figure 2: Distribution of population affected by natural disaster compared to drought between 1978 to 2004

In addition, the database reported that, in 1983, an especially severe drought in Sudan killed an estimated 150,000 people and affected another 8.4 million people over the next several years. 8.6 million people were again affected in Sudan when they were struck by drought in 1991. More recently,

3 Emergency Management Database (EM-DAT) (2008) The OFDA/CRED International Database, Universite Catholique de Louvain, Brussels, Belgium (www.emdat.be).

4 Below, R., E. Grover-Kopec, and M. Dilley (2007) Documenting drought-related disaster: A global reassessment. The Journal of Environment and Development, 19(3): 328-344.

the drought from 1998 to 2001 was reported to be the worst in 50 years, affecting millions of people across the Near East. According to EM-DAT, in 1999, nearly 40 million people were affected, including 37 million in Iran and another 3 million in Morocco, Jordan, Pakistan, and Syria. By 2000, the number had grown to nearly 50 million people as drought expanded across much of the Near East from Morocco to Tajikistan. The drought continued unabated through 2001 before beginning to lessen in most areas by 2002.

Drought management strategies are needed because they directly impact a great number of humans and animals and a significant portion the environment. Drought often results in a shortage in water resources, crop failures, loss in livestock, an increase in diseases, reduction in hydropower, increased soil erosion, increased fire occurrences and an increase in social stress. All this leads to human losses, mass migration, reduced security, and potential wars. Therefore, there is a great need to develop and implement drought management strategies and action plans in the countries affected by drought in order to increase societal and environmental resilience and enhance drought response and recovery capabilities. Clear examples of the effects of drought various countries in the Middle East are listed below.

Examples on Effects of the 1998-2001 Drought in some of the Middle Eastern countries

Region	Country	
West Asia	Jordan	180,000 farmers and herders affected; food insecurity for 4.75 million people; 1% of cereals and 40% of red meat and milk harvested affected
	Lebanon	
	Syria	47,000 nomadic households forced to liquidate their livestock assets; Urban water shortages and hydropower reductions
	Yemen	
North Africa	Egypt	
	Sudan	Sudan was struck by several droughts which resulted in famine across many parts of the nation; millions of people were affected.
	Libya	
	Tunisia	Agricultural losses and US$46 million in intervention actions (i.e., livestock vaccinations and nutrition products, subsidizing forage product prices, and attribution of yearly credit for farmers)
	Algeria	
	Morocco	1 million hectares of cropland affected, resulting in 5 million tons of wheat imports in 2001 (US$500 million in total cereal imports)

Drought action plans can help decision makers to identify sectors that are vulnerable to drought, investigate management options before a crisis and increase readiness for the implementation of the most appropriate and cost-effective strategies available. This will foster a more informed decision-making process and the development of efficient drought management program. In addition, drought management strategies and action plans can create opportunities for a broad range of stakeholders to participate in the decision-making process, which can foster capacity building, conflict resolution, and collaborative relationships.

Existing Resources and Capacities and Dissemination Systems in the Region.

Most countries formed a national committee or commission to be responsible for drought management. They also developed action plans and dissemination systems. The committees include members from ministries, universities, NGO's and research centers. International organizations, mainly FAO, ESCWA, ICARDA and UNDP helped countries in North Africa and West Asia to develop their own drought management plans and provided them with expertise. Unfortunately, many of these countries lack the resources to implement the recommended action plans.

Assessment of Drought Management Knowledge and Practices and Identify Critical Gaps

The response to drought, drought management and practices vary between countries. Some countries are more advanced in that they have a drought management system in place, while others still lack drought management strategies and policies. Below is an assessment of drought management knowledge and practices in some of the countries under this study.

Jordan

Jordan is one of the more vulnerable countries to drought. This is due to the reliance of the country on groundwater and generated runoff from rainfall as the main sources for water supply. Some of the drought indicators in Jordan include:

- Water supply shortages in the summer
- Dried springs (decreased discharges in 850 springs)
- Decrease of groundwater levels by 1 m/year on average over the last 30 years.
- Decrease in the amount of runoff
- Change in agricultural patterns in the Jordan Valley and highlands due to drop in rainfall

- Increase in imported fruits and vegetables, from Syria, Lebanon, and Egypt

The poorest people in the country live in Jordan's southern highlands. These are mainly farmers and women and live in communities that are severely affected by cumulative impacts from extensive weather related disasters, such as flash flood and drought (Jordan Rural Poverty Fact Sheet - International Fund for Agricultural Development, 2010). [5]

The government of Jordan requested FAO's technical assistance to help the country undertake a project to better understand drought and its management in Jordan, and to develop a framework for carrying out a national drought planning process. This project was authorized by FAO in May 2005, under its Technical Cooperation Programme. One of the goals of the project was to create a National Steering Committee of relevant stakeholders to help oversee and lead the project. A National Project Coordinator (NPC) from the Ministry of Agriculture was first appointed to lead the project and assist in recruiting committee members. The NPC, an FAO representative, and an international drought consultant held meetings with as many Jordanian ministries, departments, and NGOs as time would permit. The members of the National Steering Committee included:

• Secretary General, Ministry of Agriculture, Chairman
• Hashemite University
• National Centre for Agricultural Research and Technology Transfer
• Meteorology Department
• Ministry of Water and Irrigation
• Ministry of Interior
• Ministry of Environment
• Royal Jordanian Geographic Centre
• Jordanian Society for Desertification Control and Badia Development
• Directorate of Land and Water, Ministry of Agriculture
• Directorate of Projects, Ministry of Agriculture
• FAO Technical Cooperation Programme National Project Coordinator

5 Jordan Rural Poverty Fact Sheet - International Fund for Agricultural Development, 2010

The Ministry of Environment then took the lead and created policies in cooperation with the United Nations Development Programme (UNDP) and the Global Environment Facility, a financial mechanism for United Nations (UN) conventions on environment. The policies also suggest amendments to Jordan's environmental protection laws to strengthen its compliance with three UN conventions on biodiversity, climate change and desertification.

The ministry of environment formed a new committee to be responsible for the development of a national strategy for drought. The committee was led by the Ministry of Environment and reported to the Minster of Environment. This committee is comprised of 20 members from governmental ministries and institutions, universities, NGO's. The committee meets every three months to discuss a work agenda developed by the ministry of environment.

The consultant met with some of the members from the national committee as well as UNDP and FAO, and IUCN organizations to evaluate their programs on drought management in Jordan.
The ministry of environment is working on implementation of the three Rio conventions:

- National Strategy and Action Plan to Combat Desertification, 2006[6]
- National Policy on Climate Change, 2013 [7]
- National Strategy on Biodiversity

Under the desertification component, the immediate obligation from the United Nations Convention to Combat Desertification (UNCCD) is to prepare a national action plan to combat desertification. With support from UNDP, the Ministry of Environment developed a national strategy and action plan to combat desertification in 2006. The ministry is planning to update this strategy in the nearest future.

The NAP includes six major programs that are mainly “project-based”. However, these programs and the proposed projects provide a framework for an action plan to combat desertification. Each program has several projects with justification, activity, implementing agencies and initial budget. The proposed programs are:

6 National Strategy and Action Plan to Combat Desertification, Ministry of Environment/UNDP, 2006
7 Jordan's Second National Communication to the United Nations Framework Convention on Climate Change (UNFCCC), UNDP, gef, 2009.
The National Climate Change Policy of the Hashemite Kingdome of Jordan, UNDP, gef, 2013-2020.

1. Desertification information system (DIS),

2. Drought prediction and Desertification control,

3. Capacity building and institutional development,

4. Restoration of degraded ecosystems of rangelands and forests,

5. Watershed management, and

6. Human, social and economic development initiatives.

The Ministry of Agriculture, in cooperation with Food and Agricultural Organization of the United Nations (FAO), implemented a project entitled "The drought mitigation strategy in Jordan." This project ended in mid 2007[8]. A national strategy and action plan for drought management was prepared and final recommendations and conclusions were discussed in a national workshop. Recommendations included:

1. Establishing a high committee headed by the Prime Minister and membership of several ministries and institutions, such as Royal Jordanian Geographical Center (RJGC), Meteorological Department, research centers, governmental and non-governmental organizations (NGOs).
2. Formulation of the following sub-committees: technical, follow-up and evaluation of risk committees. The institutions listed above were authorized to supervise the effects of drought occurrence, establish standards for declaring drought, and write reports for the high committee.
3. Training programs on drought issues is vital for the sustainability of the work. It is also important to have an independent budget and train local communities so that they can be involved in decision-making and drought mitigation.
4. Signing of MOU's within different institutions in order to clarify duties and responsibilities of each party.
5. Training of Trainers (TOT) in order to clarify the concepts and the vision of drought issues

The following gaps were identified in Jordan drought management system:

- No independent body or unit responsible for drought management
- No standard management approach

8 National Strategy and Action Plan to Combat Desertification, UNDP, 2006.

- No regional sharing of drought information
- No drought projection
- No drought management system.
- The Drought National Action Plan (NAP) is still a new document that requires an effective awareness program and a resource mobilization strategy. It can be considered as a framework for action at the country level. A precise reference was made to it in the National Agenda.
- The link between desertification and poverty is missing.
- No database for drought data collection on national scale.
- No early warning or monitoring systems.
- No Mitigation plan.
- No link between desertification, and migration and conflicts.
- The Steering committee meets every 3 months. Members are absent frequently and the meeting's agenda items are not met within a timely fashion.
- The involved ministries and organizations do not include the actions stated in the NAP in their plans or projects. In each ministry, there is no unit specialized and responsible for drought issues, rather the responsibilities are scattered between various sections.
- The ministry of environment's role is limited to calling meetings and updating strategies and policies concerning drought. There is a need to expand this role in order to establish coordinate between various ministries so that the drought action plans are included in the ministries plans and projects.
- The members in the steering committee change frequently, which affects the follow up and understanding of the agreed upon issues.
- The Metrological department is not a member of the steering committee.

Tunisia

In Tunisia, the ministry of agriculture and environment are responsible for drought issues. There is a drought management system to reduce the effects of the drought that has been in place since 1987. The system was adopted when drought events occurred during 1987-1989, 1993-1995 and 2000-2002. During 1999, Tunisia published the first guidelines on drought management entitled "Guide pratique de la gestion de la sécheresse en Tunisie" (Louati et al., 1999) [9]. The guidelines analyzed the data and

9 Louati, M.H., Khanfir, R., Alouini, A., El Echi, M.L., Frigui, H.L. and Marzouk, A. (1999). Guide pratique de gestion de la sécheresse en Tunisie: Approche méthodologique. Ministère de l'Agriculture de Tunisie, 94 pp.

information recorded during the drought periods of 1987-1989 and 1993-1995. These guidelines consist of methodological approaches, identification of principal drought indices, description of drought preparedness and management processes, and maps of intervening parties. The drought management system in Tunisia has three major successive steps:

1. Drought Announcement: Referring to meteorological, hydrological and agricultural indicators as observed in the different regions affected by drought and transmitted by the agricultural, economic, and hydrologic districts relevant to Ministère de l' Agriculture, de l' Environment et des Resources Hydrauliques/Ministry of Agriculture, Environment and Water Resources (MARH). A drought announcement is established by means of a circumstance memorandum.

2. Warning: This announcement, qualified as warning note, is transmitted to the MARH Minister, who proposes a scheduled operations plan to the National Commission (committee), which is composed of decision makers and beneficiaries.

3. Action implementation: The National Commission is in charge of supervision of the execution of all the operation actions, in strong collaboration with the regional and specialized committees. The National Commission also supervises all operations when the drought is over.

According to the published studies and information on Tunisia drought management system, the strengths and weaknesses of Tunisia drought management system can be summarized as follows:

Strengths

- A high Presidential interest and support is devoted to the drought mitigation system in Tunisia
- The approach based on three drought management phases (before, during and after drought process), is a very important strategy and relevant to the basic elements of drought management theory
- Capital productive sharing and preservation
- Sustainability of farmers' incomes
- Integrated and optimized water resources management in Tunisia, especially during drought depending on its intensity and duration
- Water saving is a national policy

Weaknesses

- No independent body or unit responsible for drought management
- No standard management approach
- No regional sharing of drought information
- No drought projection
- The financial incidences are supported by the State budget because of the absence of insurance systems linked to drought and private sector contribution is limited
- Up until 2013, the revision of the drought mitigation was based on simple note-taking and observational findings. It lacked a thorough evaluation study
- There is a deficiency in the relations between the different institutions that provide information and data about water, which should be resolved by the establishment of the Unified Water Resources National Information System in the near future

Morocco

Morocco suffered from several droughts that sharply affected the production of basic crops such as cereal. For example, as a result of drought in 2001, approximately 1 million ha of cropland was affected, which caused the country to import approximately 5 million tons of wheat and allocate more than $500 million for their cereal imports (FAO, 2004) [10]. In addition, drought conditions in Morocco can lead to food shortages and rural malnutrition, herds perishing or being slaughtered for lack of forage, farmers temporarily abandoning their land and flocking to the cities, and increased wind erosion and desertification (Swearingen and Bencherifa, 2000). [11]

At the national level, the government of Morocco established a National Drought Observatory (NDO) in 2001 with the goal of collecting, analyzing, and delivering drought-related information, which included assessing the frequency, severity, and extent of droughts. It also assessed various effects on crop, livestock, environment, and living conditions of rural populations using objective, measurable scientific criteria.

10 Description of drought management actions [Part 1. Components of drought planning. 1.3. Methodological component] CIHEAM, 2007

11 Swearingen, W.D., and A. Bencherifa (2000) Chapter 21: An Assessment of the Drought Hazard in Morocco, In D. A. Wilhite, ed., Drought: Volume I A Global Assessment, Routledge: New York.

The NDO was placed within the Institute Agronomique et Veterinaire Hassan II, an academic institution, to facilitate interdisciplinary collaboration and give the centre a degree of neutrality in regard to policy decisions. Over time, the mandate of the NDO has broadened into playing a central role in drought planning activities in the country.

The main gaps in Morocco drought systems can be summarized as follows:

- No independent body or unit responsible on drought management
- No standard management approach
- No regional sharing on drought information
- No drought projection
- Weak coordination between various ministries and organizations
- In each ministry, there is no unit specialized and responsible for drought issues, rather the responsibilities are scattered between various sections
- Mitigation plans are mainly for emergencies and not updated regularly
- No early warning system
- No monitoring system
- No standard management approach

Syria

Syria is a semi arid country that has suffered from several drought events. The 1999-2001 drought was the worst in four decades, seriously affecting crop and livestock production in the Syrian Arab Republic, which, in turn, had serious repercussions on the food security of a large segment of the population as incomes fell sharply, particularly among the rural small farmers and herders (FAO, 2004a[12]; ESCWA, 2005[13]). For example, in 1999, drought played a role in forcing approximately 47,000 nomadic households (329,000 people) to liquidate their livestock assets, which was a primary source of long-term income (De Pauw, 2005)[14]. Therefore, many families in the rangelands eventually required food aid

12Food and Agriculture Organization (FAO) of the United Nations (2004a) Syrian Arab Republic: Capacity Building in Drought Early Warning System for the Syrian Rangelands. Syrian Project Document, TCP/SYR/3002 (T), May.
13Economic and Social Commission for Western Asia (ESCWA) (2005) ESCWA Water Development Report 1: Vulnerability of the Region to Socio-Economic Drought, United Nations: New York.
14De Pauw, E. (2005) Chapter 16: Monitoring Agricultural Drought in the Near East, In: V.K. Boken, A. P. Cracknell, and R.L. Heathcote, eds., Monitoring and Predicting Agricultural Drought, Oxford University Press: New York

during the drought years (FAO, 2004a)[15]. In addition, according to ESCWA (2005)[16], urban populations, particularly in the southern part of the Syria, suffer from water shortages due to decreases in the Euphrates River. This resulted in dry of irrigation canals and drop in hydro-powered generation.

Eventually, the economic growth was affected as agricultural production fell sharply, reducing the contribution of agricultural income to GDP. Although the government made extensive efforts to reduce the effects of the drought, especially on herders, by providing extra resources, feed rations, water and veterinary supplies, they were inadequate given the drought's scale and severity and the country's limited resources.

Between 2004 and 2006, FAO worked with the government of Syria to develop an effective early warning system for drought in the Syrian rangelands (FAO, 2007a)[17]. The project had the objectives of: training national staff in the collection, analysis, interpretation, and implementation of data in the Syrian Ministry of Agriculture and Agrarian Reform, and strengthening institutional capacity in drought early warning with particular emphasis on pastoralists and agro-pastoralists of the Syrian Steppe and its margins. The Syrian project was completed in 2006. As a result, an early warning system office and a steering committee were organized; a series of drought indicators were identified.

The early warning systems were implemented for the collection, organization, and processing of drought monitoring data (physical and social data); monthly drought bulletins have been produced regularly since 2005 in both English and Arabic; and the technical capacity to operate a drought warning system in Syria was successfully developed.

The main gaps in Syrian drought systems can be summarized as follows:

- No independent body or unit responsible on drought management
- No standard management approach
- No regional sharing on drought information

15Food and Agriculture Organization (FAO) of the United Nations (2004a) Syrian Arab Republic: Capacity Building in Drought Early Warning System for the Syrian Rangelands. Syrian Project Document, TCP/SYR/3002 (T), May.
16Economic and Social Commission for Western Asia (ESCWA) (2005) ESCWA Water Development Report 1: Vulnerability of the Region to Socio-Economic Drought, United Nations: New York.
17Food and Agriculture Organization (FAO) of the United Nations (2007a) Capacity Building for a Drought Early Warning System in the Syrian Rangelands. Terminal Statement prepared for the Government of Syria by The Food and Agriculture Organization of the United Nations. Cairo, Egypt, TCP/SYR/3002

- Weak coordination between various ministries and organizations
- In each ministry, there is no unit specialized and responsible on drought issues, rather the responsibilities are scattered between various sections
- Mitigation plans are mainly for emergencies and not updated regularly
- No early warning system
- No monitoring system
- No standard management approach

Yemen

Yemen is highly vulnerable to drought impacts. This is a serious concern as Yemen's economy largely depends on its rural natural resources. According to the Yemen Environment Authority, more than 75% of the population is rural-based and engaged in farming and pastoralism, and hence highly reliant on favorable climatic conditions for their livelihoods. Recently, Yemen has suffered from increased drought frequency, increased temperatures, and changes in precipitation patterns leading to degradation of agricultural lands, soils and terraces.

For example, the 1990-1991 drought had a great impact on the Yemeni economy and population. As agricultural production fell sharply, economic growth was affected by the reduction of agricultural income's contribution to GDP. The agricultural sector registered significant yield losses, resulting in widespread farm losses and increased poverty in rural areas. The drought highlighted the vital role that adequate rainfall and water resources play in keeping Yemen's economy profitable and sustainable, as Yemen has no perennial rivers, and depends on rainfall from water run-off and groundwater recharge. The drought had serious implecations on the food security of a large segment of the population. According to the World Bank, a sizeable portion of the population remains economically vulnerable to falling into poverty due to drought, as the Yemeni agricultural sector provides employment for 58% of the population.

The responsibility of drought and climate change issues in Yemen belongs to the Ministry of Water and Environment and Environment Protection Authority (EPA). Some of the international organizations such as UNDP, GEF, and IUCN helped Yemen in developing strategies for climate change and biodiversity loss. However, there are still no sustainable land management strategies to combat desertification and land

degradation. The primary goal of the Yemen National Adaption Program of Action (NAPA)[18] is to identify priority measures to adapt to drought variability, and translate them into project-based activities that can address Yemen's urgent needs for adapting to the adverse impacts of drought. Some of the key elements of the process include adequate stakeholder representation in all phases of the process.

The main weaknesses in Yemen related to Drought Management System are as follows:

- No independent body or unit responsible on drought management
- No standard management approach
- No regional sharing on drought information
- No drought projection
- Weak institutional structures and environmental legislations
- Lack of explicit policies to facilitate the implementation of Yemen Plans
- Lack of appropriate data collection
- Lack of adequate monitoring
- Difficulties experienced in accessing databases
- Lack of technical capacity to analyze and manipulate drought data
- Lack of quality assurance
- Inadequate institutional, technical and financial capacity to develop, modify, or interpret existing models and methodologies
- Lack of financial sources to implement the adaptation measures
- Weak coordination between various ministries and organizations
- In each ministry, there is no unit specialized and responsible on drought issues, rather the responsibilities are scattered between various sections
- Mitigation plans are mainly for emergency and not updated regularly
- No early warning system
- No monitoring system

Standard Approaches to Drought Management

The standard approaches in drought management include two main approaches:

18 Yemen National Adaptation Program of Action, Republic of Yemen Environment Protection Authority, 2009

- Reactive Approach
- Proactive Approach

Reactive Approach:

This approach is based on the implementation of measures and actions after a drought event has started and is perceived. This approach is taken in emergency situations and often results in inefficient technical and economic solutions. This is because actions are taken with little time to evaluate optimal actions and stakeholder participation is very limited.

Proactive Approach:

In this approach, all the measures are designed in advance, with appropriate planning tools and stakeholder participation. The proactive approach is based both on short term and long-term measures and includes monitoring systems for a timely warning of drought conditions. It can be considered an approach to "manage risk." A proactive approach entails planning the necessary measures to prevent or minimize drought impacts in advance. Such an approach includes preparedness of planning tools, which would enable the consequences of a possible water emergency to be avoided or reduced.

The proactive approach calls for continuous monitoring of hydrometeorological variables and water reserves in order to identify possible water crisis situations and apply the necessary measures before a real water emergency occurs. If it is not possible to avoid a water crisis that appears as natural public calamity (after a government declaration), the Drought Contingency Plan is implemented until the establishment of normal conditions. It is evident that a proactive approach, even if more complex, is more efficient than the traditional approach since it allows drought mitigation measures (both long term and short term) to be defined in advance, which improves the quality of the interventions.

The implementation of a proactive approach implies drafting plans in which the mitigation measures are clearly defined together with the instructions for their implementation. The proactive approach is recommended for drought management and will reduce the drought impacts and risks. This implies the following standard steps below:

- Establish a specialized unit or section that is responsible for drought management. It can be within one of the key ministries such as the Ministry of Agriculture, Environment or Water.

- Establish a Steering Committee from relevant ministries, NGO's, Universities, Research institutes, Farmers Associations, and private sector. The committee needs to have competences at different levels of implementation of policy and expert analysis. It might be helpful to have two committees: a policy committee and a technical committee.
- Classify and characterize the geographical area into drought zones according to vulnerability (High, Medium, Low). Drought characterization should also include a previous diagnosis of the sources, scales and reliability of the data used in the analysis. The correct drought characterization provides decision makers with a measurement of the abnormality of historical weather variability and its effects on a region.
- Develop GIS based database to house maps and drought information
- Collect metrological, hydrological, biological and socioeconomic data within the geographic zones
- Collect and share transboundary and regional metrological data through direct regional cooperation programs or the WMO joint programs or database
- Project potential future droughts based on collected metrological data using climate change projection models
- Analyze the hydrological data and identify the impact of changes in rainfall and temperature on the each zone based on the drought projection
- Develop monitoring system a regular monitoring at fixed stations in each zone will continue. Drought monitoring has the objectives to warn about a possible incoming drought, providing adequate information for an objective drought declaration and for avoiding severe water shortages, therefore this
- Update and modify the drought management plan based on new information on regular basis
- Develop early warning system that incorporate the drought projections in the classified zones and alert the various stockholders on regular basis. The warning system can be categorized into 4 mains stages; alert, alarm, emergency, and recovery
- Measure the impact of droughts in each zone and estimate the losses in each of the above listed indicators

Drought management depends on indices to detect drought conditions, and thresholds to activate drought responses. Indices and thresholds are important to detect the onset of drought conditions, to monitor and measure drought events, and to quantify the hazard. The appropriate drought index is

selected according to the type of drought. Indices may be considered as general or specific depending on the utility for which they have been devised. It is understood that this distinction is difficult. Some of the indices, however, are more appropriate for monitoring and some for the analysis of historical drought events.

The most commonly applied drought indices include the Standardized Precipitation Index (SPI), the Palmer (Drought Severity Index PDSI) and Deciles due to their simplicity. It was concluded that the easiest index to use for monitoring purposes is the SPI, which is based on a single meteorological parameter (precipitation) and the RDI that also includes evapotranspiration. Recent advances in remote sensing provide products that have a large potential as drought indices. The NDVI is widely used for monitoring and forecasting crop production world-wide and by agricultural insurance companies.

Review Standard Approaches in Drought Management

Specific definitions of drought may vary across sectors and regions. Drought generally originates from a deficiency of precipitation over an extended period of time, resulting in a water shortage for some activity, group, or environmental sector (Knutson et al., 1998)[19]. More specifically, Wilhite and Glantz (1985)[20] describe three types of droughts:

Meteorological drought: refers to a deficiency of precipitation, as compared to average conditions, over an extended period of time. Agricultural drought is defined by a reduction in soil moisture availability below the optimal level required by a crop during each different growth stage, resulting in impaired growth and reduced yields.

Hydrological drought: results when precipitation deficiencies begin to reduce the availability of natural and artificial surface and subsurface water resources. It occurs when there is a substantial deficit in surface runoff below normal conditions or when there is a depletion of ground water recharge.

19Knutson, C., M. Hayes, and T. Phillips (1998) How to Reduce Drought Risk. Preparedness and Mitigation Working Group of the Western Drought Coordination Council, Lincoln, Nebraska (http://drought.unl.edu/handbook/risk.pdf).
20Wilhite, D. A. and M. H. Glantz. 1985. Understanding the drought phenomenon: The role of definitions. Water International 10:111-120.

Socio-economic drought: occurs when human activities are affected by reduced precipitation and related water availability. This form of drought associates human activities with elements of meteorological, agricultural, and hydrological drought.

The following main indicators reflect impacts from the three types of drought:

List of Drought Main Indicators

Shortage in Water Resources
Increase in Diseases
Agricultural Losses
Livestock Losses
Drop in Hydropower
Soil Erosion
Drop in income
Stress on governments budgets
Society Instability

Impact of Standard Approaches on Drought Management Effectiveness

The adoption of standard approaches (SA) in drought management will minimize drought risk and impacts and will facilitate the decision making process. This can be seen in several areas:

- Standard approaches facilitate the step-by-step execution of drought management plans, which minimizes the risk of missing any part in the management process
- Standard approaches minimize errors and make the projections more efficient
- Standard approaches help to improve the quality of data and analysis procedures, which reflects on the projections and actions to be implemented
- Standard approaches increase readiness to face drought in a short period of time, which will reduce drought impacts
- The standard approach fosters implementation of standardized categories of alerts for different types of events. It also identifies the situations in which alerts should be sent, which prepares stakeholders for action

- The SA provides guidelines in a comprehensive manner. It provides a standard method for receiving reports and information about drought situations from the concerned Ministries/ Departments/Agencies and State Governments and thereafter issuing alert messages to all concerned. This will help in the case that there is a change of staff or committee members so all will follow the same procedures
- The SA also standardizes the information requirements for various event categories. This will facilitate the communication between various ministries
- The SA establishes protocols for alerting decision makers and the Cabinet Secretariat. It also outlines procedures for receiving and analyzing reports and issuing alerts through various modes to the concerned authorities .
- The SA is designed to specify actions that are required to be taken for reporting on drought events .
- The SA specifies duties and responsibilities for the personnel working on drought management

Using standard approaches in developed countries like Europe and the United States showed that the impact and risk from such events were much less than the countries that did not use standard approaches. This is clear in all disaster events in general and droughts in particular.

The Importance of and Need for Early Warning Systems

Early warning is the provision of timely and effective information, through identified institutions, that allow individuals at risk of a disaster to take action to avoid or reduce their risk and prepare for effective response.

As mentioned before, most countries in North Africa and West Asia suffered and will suffer from the impacts of drought on human life, livestock, agriculture, water resources, and environment. Furthermore, published results from climate change models indicate that this region will continue to face serious droughts in the future.

The IPCC Fourth Assessment Report (2007)[21] synthesized the simulation results from 21 models. Results indicated that West Asia and North Africa are likely to see a 3.5-7 centigrade temperature increase in the last 20 years of this century compared to the temperature of the last 20 years of the 20th century. In terms of precipitation, most of this region probably has had less rain (up to 50% less) in the last 20 years of this century compared to that of the precipitation in 1980-1999.

IPCC (2012)[22] also depicts the global drought scenarios for 2046-2065 and 2081-2100. Standard deviation is used for the comparison, and it is likely that there will be more Consecutive Dry Days (CDD) and higher negative soil moisture anomalies (i.e. soil moisture deficit) in West Asia and North Africa in the latter half of the 21st century.

According to the Food and Agriculture Organization (FAO, 2007),[23] future drought leads to the following:

- A decrease in water availability of up to 40 mm per year by 2080-99
- An increase in the number of dry days in most portions of the region
- A decrease in the number of frost days and an increase in heat waves in more continental areas
- A decrease in growing seasons
- A 3ºC rise in temperature could cause maize yields in North Africa to fall by 15-25%, and crop yields in West Asia to fall by 25-35%
- Less soil moisture in arid lands will exacerbate degraded lands even further
- The mean cost of climate change in the region, especially the Middle East, is predicted to result in between a 2.5% and 1.9% loss in gross domestic product (GDP), respectively, compared to a world without climate change

In light of the above projections and considering the current trend and future projections for drought in West Asia and North Africa, drought early warning systems in global, regional and national levels are

21Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

22 Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation, Field, C.B., V. Barros, T.F. Stocker, D. Qin, D.J. Dokken, K.L. Ebi, M.D. Mastrandrea, K.J. Mach, G.-K. Plattner, S.K. Allen, M. Tignor, and P.M. Midgley (Eds.). Cambridge University Press, The Edinburgh Building, Shaftesbury Road, CambridgeCB2 8RUENGLAND, 582 pp.

23 Food and Agriculture Organization (FAO) of the United Nations (2007) AQUASTAT Main Country Database (http://www.fao.org/nr/water/aquastat/dbase/index.stm)

necessary because these systems provide the timely and reliable information necessary to make decisions regarding the management of water and other natural resources. Preparedness and early warning are the key factors for later operational management and help to reduce social vulnerability to drought by:

- Establishing a drought plan
- Identifying alert mechanisms
- Establishing the links between drought, water and development policies

Scientific advances in seasonal to inter-annual climate forecasts and monitoring systems create the possibility to implement early warning systems in many regions, especially where the data and information systems are in place.

Impact of Application of Early Warning Systems in the Selected Countries

The impact of early warning systems is highly significant in saving people, livestock, crops and environment. In Europe, it is estimated that hydro-meteorological information and early warning systems have saved several hundreds of lives per year, between 460 million and 2.7 billion Euros of disaster asset losses per year, and creates 3.4 - 34 billion additional benefits per year through the optimization of economic production in weather-sensitive sectors (agriculture, energy etc.).

In North Africa and West Asia, the published surveys and studies on drought, indicated that most countries in the region do not have well-functioning drought monitoring systems that would allow them to take timely action to mitigate the effects of drought. Even though the meteorological networks in most countries are adequate and well-equipped, they are poorly prepared to function effectively as a drought early warning system because of inadequate analytical tools required for drought monitoring, unsuitable information products, and insufficient data sharing.

However, there is an example from North Africa in Morocco where they established a National Drought Observatory (NDO) in 2001 with the goal of collecting, analyzing, and delivering drought-related information in a timely manner (De Pauw, 2005),[24] which includes assessing the frequency severity of drought. Even though even great strides have been made in these efforts in North Africa and West Asia,

[24]De Pauw, E. (2005) Chapter 16: Monitoring Agricultural Drought in the Near East, In: V.K. Boken, A. P. Cracknell, and R.L. Heathcote, eds., Monitoring and Predicting Agricultural Drought, Oxford University Press: New York

in general, there are still many challenges to overcome in developing effective drought monitoring. Some of the most pressing challenges include:

- Enhancing data quality and collection network densities
- Reducing the cost and increasing the sharing of data
- Making early warning information more accurate and user friendly
- Integrating physical and social drought indicators into systematic and comprehensive monitoring and early warning systems
- Providing support to create and maintain systems.

Assessment of Required Resources and Capacity for Drought Monitoring

The required resources for drought monitoring include national resources and international support. On the national level drought monitoring requires, firstly, a functional observation network. The spatial and temporal variability of rainfall is very high in the semi-arid and arid areas prone to drought. It is recommended to establish an observational network as follows:

- Automatic weather station
- Automatic rain-gauge
- Ground water table observations
- Surface water flow measurements
- Regular updated satellite data

The rainfall data not only needs to be accurately measured but it is required to be measured and transmitted on real time basis. Telemetric rain gauges are useful in recording real time rainfall data, which enables near time analysis. The availability of real/near real time rainfall/weather data makes it possible to develop early warning systems. The digital data obtained from telemetric rain gauges enables not only efficient database management but also enables development of operational early warning systems. Automatic weather stations and rain gauges need to be distributed at appropriate places to enable micro level analysis and forecasting.

The observation network can be established from the existing stations, which belong to various ministries or metrological departments in each country. In order to get proper monitoring, the

observational network would require a reasonably dense observational network. It also requires a skilled and operational maintenance staff to run the network.

Drought monitoring indicators based on climate data and remote sensing products are at present the best available tools to monitor drought over large regions and time periods (Vicente-Serrano et al., 2012) [25]. The two most widely used indicators are the Standardized Precipitation Index (SPI) and the Palmer Drought Severity Index (PDSI). In addition, the surface water supply index (SWSI), the standardized water indexes (SWI), the field monitoring and remote sensing systems and the socio-economic indicators. These indicators should be used in an integrative way better interpret drought severity. Below is a list of the basic indicators and the measurement means.

Monitoring Indicators	Monitoring Means
Rainfall	Rainfall Gauging Stations
Water supplies (domestic, livestock)	Household Survey
Vegetation Cover	Satellite imagery (NDVI)
Livestock	Livestock's Survey

Based on these indicators, a system of drought status classification can be developed, which recognizes 4 stages of drought:

Drought Stage	Indicators
Advisory	Indicators remain generally within the expected seasonal ranges
Alert	Marked negative changes in environmental indicators, cumulative rainfall <70% of mean, and/or an unusually low asset status due to previous losses
Alarm	Marked negative changes in environmental and rural economy indicators and/or cumulative rainfall <50 of mean
Emergency	Strongly negative changes in environmental, economic, and human welfare indicators prevail

[25] Vicente-Serrano S. M. et al. 2012: Challenges for drought mitigation in Africa : The potential use of geospatial data and drought information systems. Applied Geography, 34, 471-486.

On the international level, there are several centers with advanced technology that can support and help countries in drought monitoring by providing them with satellite images and climate conditions projections. Some of these resources include:

- The Experimental African Drought Monitor operated by the Land Surface Hydrology Group at Princeton University with support from the UNESCO International Hydrology Program
- The Global Drought Monitor, developed by the Department of Space and Climate Physics of the University College London
- The US Geological Survey (USGS) Famine Early Warning Systems Network (FEWS NET) Data Portal, which is probably the most comprehensive drought monitoring system available. This portal is provided by the USGS FEWS NET Project, part of the Early Warning and Environmental Monitoring Program at the USGS Earth Resources Observation and Science (EROS) Center. It provides access to geo-spatial data, satellite image products, and derived data products in support of FEWS NET monitoring needs throughout the world. 20 indices including SPI, Daily 10-day Moisture Index, etc. are mapped and easily accessed.

The second important requirement is the GIS database to house the data from the observation network and international centers. This requires professional staff to operate the database mainly in the analysis part where the metrological data will be linked with hydrological, and socioeconomic data.

The third requirement is the transfer of the monitoring results into action plans at all levels. There needs to be a drought management committee with technical expertise that will communicate monitoring outcomes with all stakeholders.

Experience in Including Micro-finance and Index based Insurance in the Region

The farmers are the most affected group due to drought risk. In developing countries most farmers/farming companies have their own insurance system to compensate them in drought cases. However, in developing countries in general and countries in North Africa and West Asia, there is a lack of such systems. In some of these countries the government will give partial compensation due to drought while others do not provide any kind of compensation to farmers groups affected by drought. On the international level, some of the international organizations provide certain types of compensation in the form of technical assistance, tools, free seeds and fertilizers.

The compensation schemes are considered as part of wider term micro-finance. Micro-finance refers to small savings, credit and insurance services extended to socially and economically disadvantaged segments of society. Presently, a large part of micro finance activity is mostly confined to credit. However, there are many cases in Africa, Asia and Europe where the micro-finance targets drought insurance.

In Kenya, farmers increasingly fear massive weather-related losses. UAP Insurance, Syngenta Foundation and mobile operator Safaricom announced a major expansion of Kilimo Salama, an innovative and affordable crop insurance program. This program will now cover the expected loss in value of farm harvests, crops and livestock affected by drought and flooding occurrences.[26] The new program, called Kilimo Salama Plus, builds on the original Kilimo Salama, Kiswahili for "safe farming," which was launched last year. It uses a low-cost mobile phone payment and data system that is linked to solar-powered weather stations to issue an insurance policy and rapidly compensate farmers for investments in seeds, fertilizer, and other inputs that are lost to either insufficient or excessive rains. Agricultural insurance is particularly important in Kenya and elsewhere in Africa today as the extreme weather patterns generated by climate change are introducing greater volatility to food production and food prices. According to Syngenta Foundation, there are 12,000 farmers in Kenya that take advantage of the original Kilimo Salama. The target was to reach 50,000 farmers with Kilimo Salama Plus in 2013 year and provide far more insurance options.

Morocco is one of the Arab countries that successfully adopted the insurance approach for cereal production. This approach was based on the difference between average and potential yields.

Capacity Needs Assessment of National Policy Makers in the Region

Human resource development, training, education and capacity building are essential components of the strategies for effective drought mitigation and management. The objective of capacity building is to put in place a systematic functional mechanism that incorporates the utilization of human capital. A realistic national training and capacity building program for drought management needs to be formulated and implemented. A program for resource enhancement encompassing all institutions,

[26] UAP Insurance, Syngenta Foundation and mobile operator Safaricom, Kilimo Salama micro insurance program, 2011.

organizations and individuals also needs be developed. Capacity development and training programs requires the following:

- Identification of the target group: training is the most important activity of all capacity development programs. Training needs have to be identified and appropriate training programs should be designed and conducted at all levels while involving the entire spectrum of stakeholders (from government/NGOs and community). This must occur in order to fully address the needs of sensitization, knowledge/information management and skills. The target groups identified for training and capacity development will focus on government officials including policy makers, NGO's, academic institutions who are part of the steering committee.
- Training needs assessment: Training Needs Assessment (TNA) of drought management is needed to be carried out first to properly identify the training areas required based on strengths and weaknesses of trainees

Special focus will be given to water resources, policy, socio-economic, legal, soil, environment and ecology related issues. Training can take different forms such as organizing special training session for policy makers or other groups, meetings, conferences, workshops, self-learning media, CDs, manuals and standard procedures.

Review of Drought Management Policies in the Middle East

There are variations between countries concerning drought management polices and response to droughts. Recently, many Arab countries have become more concerned with the problem of drought and some progress in dealing with this natural disaster has been achieved. Among the actions taken is the establishment of national drought committees that are in place to reduce the effects of drought on the populations, crops and livestock, and hence to improve the livelihood of the poor. Local committees have also been constituted to implement drought relief measures set up by the national drought committee.

With the assistance of international organizations, the Arab countries have focused on drought relief measures. In fact, as a response to recent reoccurring droughts, most of the Arab countries have established a drought unit where different concerned ministries are represented to coordinate efforts to deal with the drought crisis and its impacts. This is a positive initiative and it has solved some of the conflicts and the lack of coordination among different administrations and agencies concerned with

water and drought issues. A national contingency plan and drought emergency program to monitor (through inter-governmental National Committee) and alleviate drought impacts on people, crops, livestock and agro-pastoral systems is launched. The National committee is usually headed by a high political authority, such as the Minister of Agriculture, or even the prime minister (in the case of Morocco). Provincial or local committees are also formed to implement drought relief measures adopted by the national committee. Among the coping measures adopted in the region are, the provision of supplementary feeds to safeguard livestock as the predominant investments.

Although Governmental plans are mainly based on crisis management of drought, they also recognize the urgent need to develop long term risk management strategies based on drought preparedness and mitigation. This is due to the effort of international organizations to enhance the awareness of the seriousness of drought especially to decision makers. In fact, it is recognized now that the Arab countries have become more involved in regional and international workshops, networks and research programs aiming at the development of strategies for long-term drought management.

SECTION 2: Case Study of Israel's Water Resource Management and Application of CIHEAM Drought Management Guidelines

Source: Kalman (n.d.)[27]

Brief Overview of CIHEAM Guidelines

The purpose of CIHEAM's proposed guidelines is to provide a methodological framework for a drought management plan. CIHEAM's guidelines include five major components: 1) The planning Framework, 2) The Organizational Component, 3) the Methodological Component, 4) The Operational Component, and 5) the Public Review Component.

The Planning Framework

The planning framework involves defining the planning purpose and process for developing drought planning at the local, regional and national scales. The planning framework is an important step in the development of a common language among stakeholders, which will be integral throughout the entirety of the planning process.

The Organizational Component

This component helps the user to understand the legal and institutional frameworks involved in the drought management planning process. It also helps to identify which drought mitigation tools and methodologies are most suitable for a specific the specific geographic location. Coordination with

[27] Israel - Eran Kalman. (n.d.). Retrieved from http://blog.ibs-b.hu/2011/11/25/israel-eran-kalman/

various institutions, compilation of societal responses to drought, and the provision of public information are also involved in this component.

The Methodological Component

The Methodological Component Involves developing the indicators of risk to drought and the compilation of scientific and technical approached to drought; defining methods to combat drought in the Mediterranean region; determining indicators of social vulnerability to drought based on academic methods; and developing technical studies in order to strengthen the use of indices when defining drought.

The Operational Component

The Operational Component includes early warning systems and preparedness measures; prioritizing efforts during drought and water scarce situations; determining social and physical thresholds as defined by drought indices; and defining and evaluating implementation of actions.

The Public Review Component

The purpose of the Public Review Component is to review and revise the four other components as necessary. This involves stakeholder dialogue, workshops, interviews, and questionnaires in order to receive feedback and update drought plans so that they will be most effective.[28]

The Planning Framework Component Applied to Israel

Section Description: *The planning framework involves defining the planning purpose and process for developing drought planning at the local, regional and national scales. The planning framework is an important step in the development of a common language among stakeholders, which will be integral throughout the entirety of the planning process.*

[28] Drought Management Guidelines, European Commission-EuropeAid Co-operation Office, Euro-Mediterranean Regional Programme for Local Water Management (MEDA Water), Mediterranean Drought Preparedness and Mitigation Planning (MEDROPLAN)

Current Drought Management Goals in Israel

Israel intends to tack the issue of drought by creating a sustainable policy that allows them to combat drought proactively, recovering a large amount of effluents through wastewater recycling, incorporating money saving projects, continuing to utilize brackish water and seawater desalinization plants and engaging in organizational change (Zaide, 2011)[29].

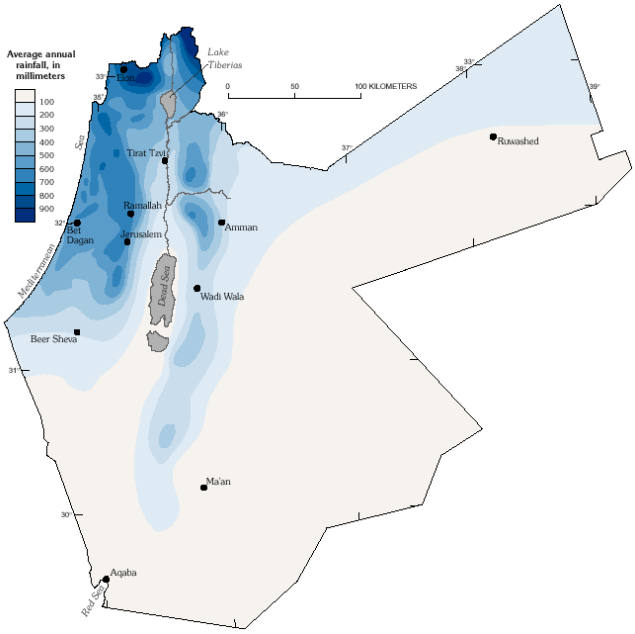
Climate in Israel

Israel has a very diverse topography, which results in major temperature variations and climatic conditions across the country (CIA World Factbook, 2008)[30]. Throughout the country, the land can be classified as arid, semi-arid and even reaching hyper arid regions. It is not unlikely for Israel to experience droughts that last multiple years, which has occurred numerous times in Israel's history. Near droughts and short periods of heavy rainfall are also characteristic of the Israeli environment (Zaide, 2011). Israel typically has two distinct seasons consisting of a cold, rainy season and a hot, dry season. The colder rainier months occur between October and April, while the hotter and drier months occur between May and September (Ochsenwald, 2013)[31]. The northern part of the country tends to be much wetter and experiences more precipitation on average than the southern parts of Israel. In non-drought conditions the Upper Galilee region in the north receives approximately 44 inches of rain or 1,120 mm of rain per year. In large cities that are situated around the costal plain the average typical rainfall is about 20 inches or 508 mm per year. In the southern parts of the country, like the 'Arava Valley, where the climate tends to be much drier, the average annual rainfall is about 1 inch or 25 mm per year. Israel typically experiences about 60 days of rain in one year and usually occurs between the months of October and April. It is not unusual, however for Israel to experience severe water shortages and droughts, especially in the summer months (Ochsenwald, 2013).

[29] Drought and Arid Land Water Management. (2011). Retrieved from http://www.un.org/esa/agenda21/natlinfo/countr/israel/drought.pdf

[30] The World Fact Book (2008). Retrieved from https://www.cia.gov/library/publications/the-world-factbook/geos/is.html

[31] Ochsenwald, W. L. (2013). Climate. Retrieved from http://www.britannica.com/EBchecked/topic/296740/Israel/23070/Climate



Precipitation in Israel[32]

Temperatures in Israel tend to vary based on elevation and proximity to costal areas. For example, areas near the coast of the Mediterranean Sea experience milder temperatures in relation to the rest of the country. These costal communities experience temperatures that range cooler temperatures of approximately 61 degrees F (16 degrees C) in January and 84 degrees F (29 degrees C) in August. Costal cities are also often much more humid than inland areas, particularly during the winter months (Ochsenwald, 2013). It is not unlikely for the areas in the higher elevations to see some snow during the winter. These northern cities, like the Upper Galilee tend to have cool nights throughout summer and winter. The city of Elat is an exception. Elat is a southern city situated near the Red Sea but has some of the climatic characteristics of Jordan Valley, The Negev and 'Arava Valley, which tend to be much hotter than the northern coast, ranging in temperatures from 70 degrees F in January to 114 degrees F (46 degrees C) in August. In this area the average high is approximately104 degrees F (40 degrees C) (Ochsenwald, 2013).

[32] Precipitation in Israel - Bing Images. (n.d.). Retrieved from http://www.bing.com/images/search?q=precipitation+in+Israel&qs=n&form=QBIR&pq=precipitation+in+israel&sc=3-23&sp=-1&sk=#view=detail&id=3F0F66B35734FBF313005B5532FD7D28F6F8D9A2&selectedIndex=7

Major Water Sources

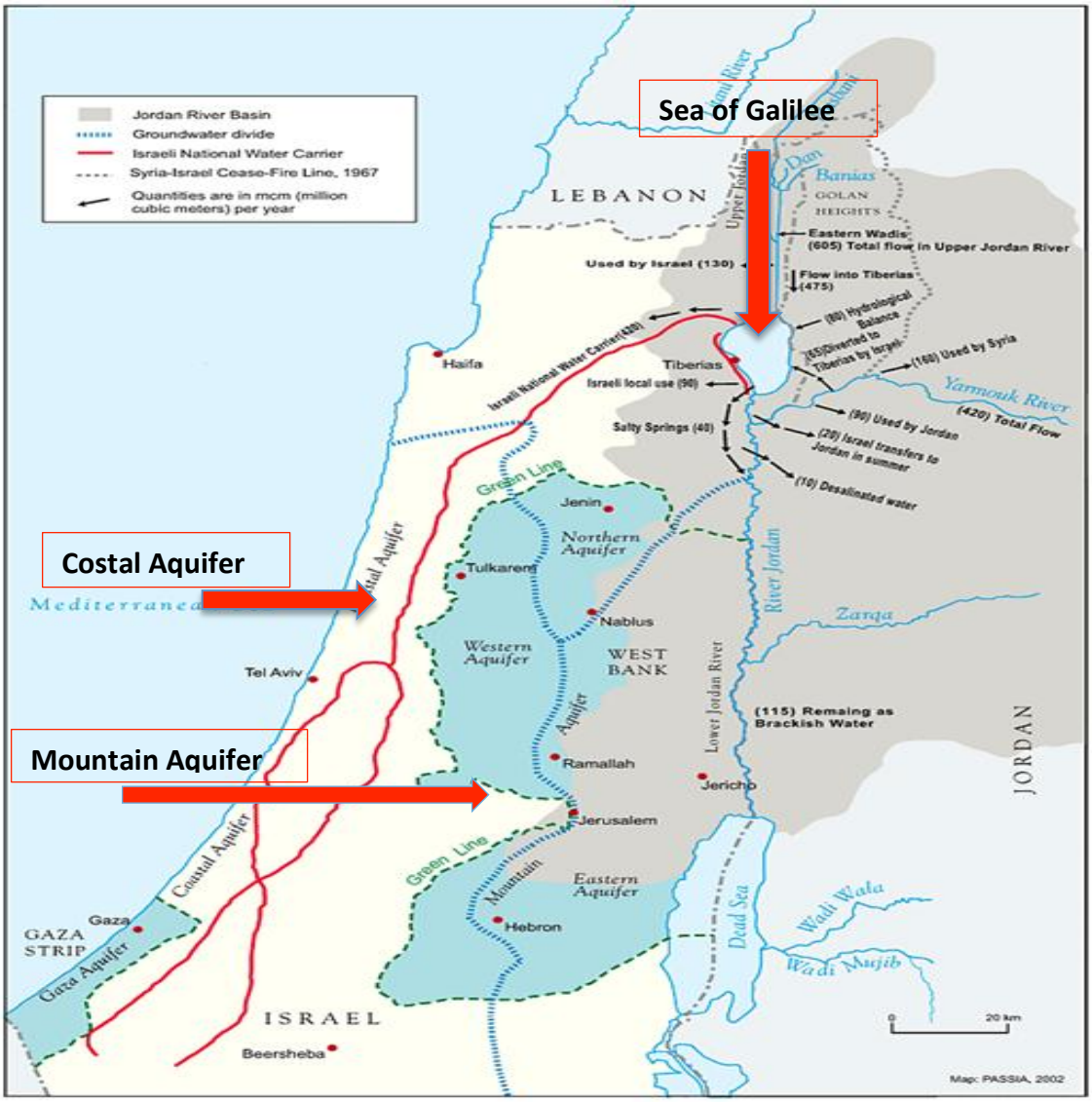
There are three main water resources in Israel. They are the Costal Aquifer, the Mountain Aquifer and Lake Kinneret (also known as the Sea of Galilee). Based on values from the Jewish Virtual Library[33], the Costal Aquifer has annual renewable quantities of approximately 320 Million Cubic Meters (MCM) per year. The Mountain Aquifer has annual renewable quantities of about 370 MCM per year, and the Sea of Galilee supplies the largest amount of water at 700 MCM of renewable water per year (Israel's Chronic Water Problem, 2014). These values typically fall within a range of plus or minus 100 MCM per year. These statistics are summarized in the table below.

Resource	Renewable Quantities (MCM/Year)
The Costal Aquifer	320
The Mountain Aquifer	370
Lake Kinneret (Sea of Galilee)	700
Additional Regional Resources	410
Total Average	1,800

Source: (Israel's Chronic Water Problem, 2014)

The Map below shows the geographic location of the major sources of water in Israel. The Sea of Galilee is located in the northern portion of the country near Lebanon and the Yarmouk River. As the name suggests, the costal aquifer is located along the coast of the Mediterranean Sea and spans almost the entire length of the country. The Coastal Aquifer is also adjacent to the Gaza Strip. The Mountain Aquifer is located south of the Sea of Galilee, east of the Costal Aquifer and near the West Bank.

[33] Water in Israel: Israel's Chronic Water Problem. (2014). Retrieved from http://www.jewishvirtuallibrary.org/jsource/History/scarcity.html



Source: (Bethlehem Bloggers, 2006)[34]

The Sea of Galilee

The Sea of Galilee is a monomictic lake that is also frequently called as Kinneret. It's measures 13 miles (21 km) in length, 8.1 miles (13 km) in width, and has a depth of 141 feet (43 m) at its maximum. On average the depth of the Sea of Galilee is 84 feet (25.6 meters) (Lake Kinneret, 1999)[35]. Its total circumference is 33 miles, making it the largest freshwater lake in Israel. When completely full its

[34] Bethlehem Bloggers: Voices from the Bethlehem Ghetto: August 2006. (2006). Retrieved from http://bethlehemghetto.blogspot.com/2006_08_01_archive.html

[35] Lake Kinneret | World Lakes Database - ILEC. (1999). Retrieved from http://wldb.ilec.or.jp/Lake.asp?LakeID=ASI-09

surface area amounts to 64.4 square miles (166 square km)(Kinneret General, n.d.)[36]. The Sea of Galilee is one of the lowest lying lakes in the world, only second to the Dead Sea, another one of Israel's major water sources. It is the lowest fresh water lake in the world and lies between 686 feet and 705 feet below sea level (Lake Kinneret 1999).

The primary inflows of the Sea of Galilee are from the upper Jordan River; it is also subject to receiving inflow from local runoff. The lake primarily flows out into the lower Jordan River. The Sea of Galilee is geographically situated in the northeast portion of Israel, in close proximity to the Jordan Rift Valley. Because the Jordan Rift Valley was formed by the separation of the Arabian Plate and the African Plate, the area surrounding the valley, including the Sea of Galilee is likely to experience the occurrence of earthquakes, and although not as prevalent currently, volcanic activity. The geology of the area surrounding the sea is largely basalt and other igneous rock, given the presence of volcanoes.

In 1964 the National Water Carrier (see below for further description) was built. A large percentage of the population in Israel is located in very arid regions where major water sources are not easily accessible. The National Water Carrier acted as a system to take water from the Sea of Galilee and transport it to major population centers for drinking water and agricultural purposes.

The Sea of Galilee not only provides drinking water to Israeli citizens but because of the Israel-Jordan peace treaty, Israel is required to supply Jordan with 50 million cubic meters of water per year. Along with this tremendous amount of water supplied to Jordan, 400 million cubic meters of water is pumped from the Sea of Galilee through the National Water Carrier each year (Kantor, n.d.)[37].

Ecological and Hydrological Concerns

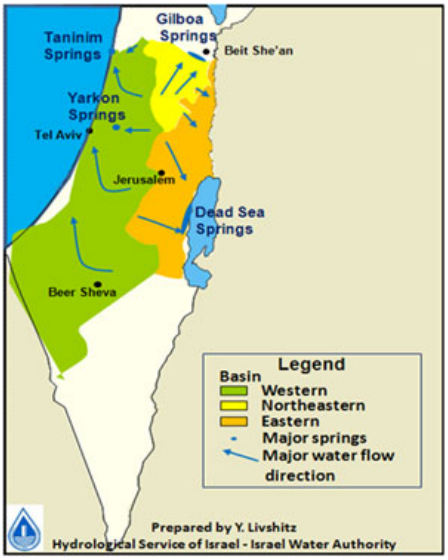
The Sea of Galilee historically has had high levels of chlorine as a result of the underlying saline springs. In 1964, around the time of the construction of the National Water Carrier, the saline water from these springs were largely diverted to the southern portion of the Jordan River (Race to Save the Sea, 2009)[38] The salinity of the Sea of Galilee is highly dependent on the influx of water from its freshwater sources

[36] Kinneret General (n.d.). Retrieved from http://kinneret.ocean.org.il/dc_lake_general.aspx
[37] Kantor, S. (n.d.). The National Water Carrier(Ha'Movil Ha'Artsi" Retrieved from http://research.haifa.ac.il/~eshkol/kantorb.html
[38] Race To Save Sea Of Galilee From Disaster. (2009, May 5). Retrieved from http://news.sky.com/story/690934/race-to-save-sea-of-galilee-from-disaster

from the Jordan River. In 1992, for example, Jordan River influxes were very high and this resulted in lower amounts of salinity in the Sea of Galilee. Conversely, between 1988 and 1991, the combination of low water levels and low influx into the lake from freshwater sources resulted in higher than average salinity levels. Basin Countries include Israel, Syria and Lebanon.

The Mountain Aquifer

The Mountain Aquifer is made up of three aquifers, the Western Aquifer, the North-Eastern Aquifer and the Eastern Aquifer (Prospects of Efficient, 2005)[39]. It not only supplies water for Israel, but is a major water source for the Palestinians.



The Mountain Aquifer[40]

The Western Aquifer is also known as the Yarjkon-Taninim Aquifer and is the biggest of the three aquifers that make up the Mountain aquifer (Shapland, 1997)[41]. It possesses an annual yield of approximately 362 MCM. Of the approximately 362 MCM of water in the aquifer, about 40 MCM is considered brackish water. Israel usually extracts water from this aquifer by using deep groundwater wells. Israel has about 300 wells within the Mountain Aquifer (Shapland, 1997).

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[39] Prospects of Efficient Wastewater Management and Water Reuse in Palestine (2005). Retrieved from https://web.archive.org/web/20100627045600/http://home.birzeit.edu/iews/images/stories/cvs_files/zmimi/Prospects_of_Efficient_Wastewater_Management.pdf

[40] The mountain aquifer - Bing Images. (n.d.). Retrieved from http://www.bing.com/images/search?q=The+mountain+aquifer&qpvt=The+mountain+aquifer&FORM=IGRE#view=detail&id=D7BB9EB1147017986BF8DA4A203058DD39D879F5&selectedIndex=265

[41] Shapland, G. (1997). *Rivers of discord: International water disputes in the Middle East*. New York: St. Martin's Press.

The Northeastern Aquifer is also known as the Gilboa-Bet She'an Aquifer in Israel (Shapland, 1997). Its annual yield is about 145 MCM but of that quantity, approximately 70 MCM is considered to be brackish. The water from this aquifer is recharged primarily by precipitation that originates from the West Bank (Shapland, 1997).

The Eastern Aquifer lies entirely within the West Bank. Annually, this aquifer receives about 172 MCM, about 80 MCM of which are is brackish water. Unlike the other aquifers, the Eastern Aquifer's primary drainage is from springs and not groundwater wells (Shapland, 1997).

Ecological and Hydrological Concerns

The hydrological characteristics of the Mountain Aquifer make it very susceptible to the pollution that comes from groundwater. Much of this pollution is derived from untreated sewage that seeps underground to the aquifer. Because this aquifer is located on the Israeli-Palestinian boarder, the aquifer is even more vulnerable to the pollution that comes from these two countries. Along those same lines, because the aquifer is a major water source for both countries, it is in danger of becoming depleted from overuse and over pumping (Shared Israeli-Palestinian, n.d.)[42].

The Costal Aquifer

As previously mentioned, the Costal Aquifer runs along the western coast of Israel. The Gaza Strip is located at the southern portion of the aquifer (Shapland, 1997). The costal aquifer has about 320 MCM of renewable water quantities per year. Like many of the water bodies and aquifers in Israel, the water is shared between multiple countries. The Costal Aquifer is the only water source in which the people living in the Gaza Strip can receive their water (World Bank, 2009)[43].

Ecological and Hydrological Concerns

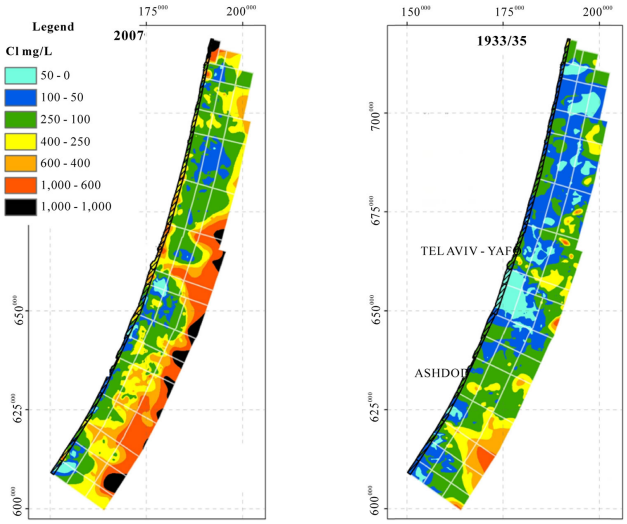
Israel as dug a number of deep water wells along the Costal Aquifer, which often prohibits the transfer of water to the Gaza Strip. This becomes problematic for the population living in the Gaza Strip. Furthermore, the Palestinians are not authorized to transfer water from the West Bank area to the Gaza

[42] Shared Israeli-Palestinian groundwater is threatened by pollution. (n.d.). Retrieved from http://foeme.org/www/?module=projects&record_id=53

[43] *West Bank and Gaza: Assessment of restrictions on Palestinian water sector development*. (2009). Washington, D.C.: Middle East and North Africa Region, Sustainable Development, World Bank.

Strip, which places even more stress on the Costal Aquifer (Bashir et al., 2006)[44] The combination of water stress originating from the Israeli-Palestinian water demand and the numerous deep groundwater wells in the aquifer has resulted in an extreme amount of sweater intrusion. The presence of nitrates from wastewater and agriculture is another issue in the Costal Aquifer. Currently, a mere 5-10% of water from the Coastal Aquifer is considered potable. As of 2000 the water located in the Gaza area from the Coastal Aquifer is so polluted that it is no longer drinkable (World Bank, 2009).

The maps below displays chloride levels along the Costal Aquifer. These maps shows a great amount of chloride inundating the aquifer in 2007 compared to 1933-35 with a majority of its concentration in the Gaza region.



Salinity levels in the Costal Aquifer

The Dead Sea

The Dead Sea is also is also often called the Salt Sea. It is an Endorheic hypersaline lake that lies lower below sea level than any other body of water in the world at approximately 1,401 feet (427 meters) below sea level (Encyclopedia Britannica, 2014).[45] It is located in the Jordan Rift Valley with the nations of Jordan on the eastern side and Israel and Palestine on the western side. The Dead Sea is 1004 feet (306 meters) in depth, 31 miles (50 km) in length and 9 miles (15 km) in width. The average water depth

[44] Bashir, B., Talhamy, M., Allah, N. '., & Rabi, A. (2006). *Water for life: The dilemma of development under occupation: The obstacles to achieving the millenium development goals and water rights in the occupied Palestinian territory*. Jerusalem: Palestinian Hydrology Group.

[45] The Editors of Encyclopædia Britannica. (2014). Dead Sea (lake, Asia). Retrieved from http://www.britannica.com/EBchecked/topic/154254/Dead-Sea

is approximately 656 feet (200 meters) and its surface area is 234 square miles (605 square kilometers). Unlike the Sea of Galilee the Dead Sea does not have any major outflow areas, but the Jordan River is the main tributary of the Dead Sea (Encyclopedia Britannica, 2014).

Based on estimates from 2011, the Dead Sea is reported to be 34.2% saline, which makes it one of the saltiest water bodies on earth. Remarkably, its salinity levels are almost 10 times greater than that of the ocean (Encyclopedia Britannica, 2014). This high level of salinity is unsuitable for many forms of wildlife. Basin Countries include Israel, Jordan, Syria, Lebanon, Palestine, and Egypt.

Ecological and Hydrological Concerns

Unfortunately there have been major declines in the water levels of the Dead Sea. Much of this is due to the fact that the water from the Jordan River, the main tributary of the Dead Sea, is being diverted to the north. Currently the Dead Sea is seeing a water level drop rates of approximately 3 feet (1 meter) per year. This drop in water level has caused a subsequent decrease in groundwater levels allowing for subterranean brines to be displaced by freshwater causing sinkholes and subsurface cavities in the western shore (Klein and Flohn, 1987).[46]

Uses of the Dead Sea

Of the notable planned Dead Sea projects in the Jordan National Red Sea Development Project (JRSP), projected to be completed in 2017. The plan is to design a system that takes water from the Red Sea, which is situated near Aqaba, and funnel that water into the Dead Sea. This project entails desalinating water along the system in order to equip Jordan with a greater supply of fresh water. The consequent brackish water that will accumulate will be sent to the Dead Sea so that its water levels will be replenished. This project also benefits Israel, as some of the water in this system will be transported to the Negev region. There are concerns that the amount of wastewater sent to the Dead Sea from this project will cause potential negative environmental impacts to the Dead Sea, especially in light of the planned accelerated rate of extraction from the Red Sea (300 million meters cubed/year). The downhill portion of the Dead Sea is also planned to be used for Hydropower (Jordan to refill the Dead Sea, 2009)[47].

[46] C. Klein, A. Flohn. 1987. *Contribution to the Knowledge in the Fluctuations of the Dead Sea Level*, Theoretical and Applied Climatology. pp. 151–156

[47] Jordan to refill shrinking Dead Sea with salt water. (2009, October 10). Retrieved from http://www.telegraph.co.uk/earth/earthnews/6285055/Jordan-to-refill-shrinking-Dead-Sea-with-salt-water.html

National Water Carrier

The National Water Carrier was completed in 1964 and is the biggest water project in the Nation of Israel (Kantor, n.d.)[48]. Tahal was responsible for the design of the National Water Carrier and its construction was completed by Mekorot. The main purpose of the project was to transfer water from the Sea of Galilee, which is situated in the northern parts of the State of Israel, to the center and southern parts of the country. The center of the country was in need of water because of how densely populated it was while the south was in need to water due to its arid climate. One of the goals of the National Water Carrier was to increase efficiency and regulation of water resources in Israel.

In one day, approximately 1.7 cubic meters of water flows through the system (Waldoks, 2008).[49]That equates to about 72,000 cubic meters in an hour. The total system is approximately 81 miles (130 kilometers) long and is comprised of pumping stations, giant pipes, canals, tunnels and reservoirs.

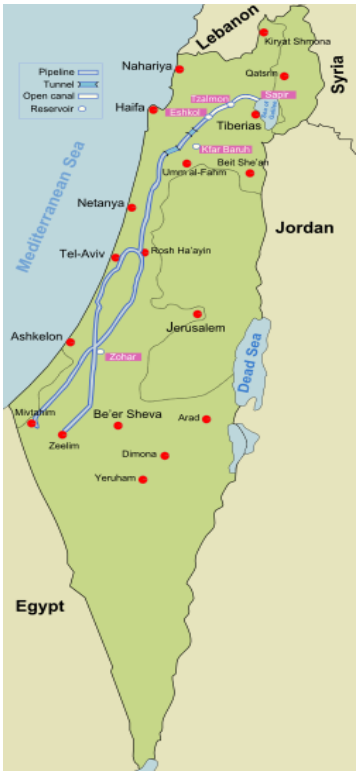
Initially, 80% of the water from the system was designated for agricultural purposes while only 20% was allocated for drinking water. Because of population growth and an increased standard of living, however, by the 1990's, the National Water Carrier began to supply Israel with approximately 50% of their drinking water.

The water flows from the shore of the Sea of Galilee at the Sapir Pumping Station into the Jordan Canal, which travels along the mountainside for about 11 miles (17 km). The full pipes can carry up to 8.9 feet of water (2.7 meters). Remarkably, the water in this section flows mainly by gravity. From the Jordan Canal, the water is then transferred to the Tzalmon Reservoir located in the Nahal Tzalmon valley. This is also the location of the Tzalmon Pumping Station, which was created to pump water up an additional 337 feet (115 meters). The system continues to travel under the village of Elibaun to the Beit Netofa Canal. This canal allows water to travel an additional 17 kilometers (Kantor, 2008). There are two significant reservoirs located at the southern portion of the Beit Netofa Canal. The first of the two reservoirs is a sedimentation pond. This sedimentation pond holds about 1.5 million cubic meters and allows for the purification of water by the process of sediment settling to the bottom of the reservoir.

[48] Kantor, S. (2008.). The National Water Carrier(Ha'Movil Ha'Artsi" Retrieved from http://research.haifa.ac.il/~eshkol/kantorb.html

[49] Waldoks, Ehud Zion. (2008). "Inside the National Water Carrier". Jerusalem Post. Retrieved 2008-04-05.

The second reservoir has a total capacity of 4.5 million cubic meters and controls the influx of water from the system's canals and pumping stations in relation to the outflow of water into closed pipelines (Kantor, 2008). The amount that can go through the pipeline depends on the nations water demands at that particular time. Chemicals are added to the water and other tests are performed near the end of the system so the water will meet drinking water standards (Kantor, 2008).



National Water Carrier of Israel[50]

Mekorot- The Major Water Provider

Mekorot was the first major water company in Israel and was developed in 1937, 11 years before the State of Israel came into existence in 1948. Mekorot is a government-owned corporation and is an integral part of the water resources, providing Israel with 90% of its total drinking water. Furthermore, 80% of its water supplies come from Mekorot (Mekorot, n.d.)[51].

[50] National Water Carrier of Israel. (n.d.). Retrieved from http://en.wikipedia.org/wiki/File%3ANational_Water_Carrier_of_Israel-en.svg

[51] Mekorot, Israel's National Water Company. (n.d.). Retrieved from http://www.mekorot.co.il/eng/Pages/default.aspx

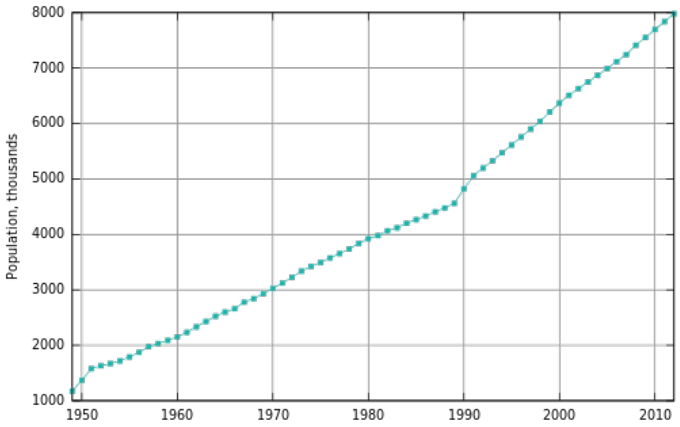
Mekorot's services include: Desalinization, water supply, water control, water management, rain enhancement, sewage purification and infrastructure (Mekorot, n.d.).

Mekorot oversees the following operations (Mekorot, n.d.):

- 800 pumping stations
- 1,200 wells
- 2,400 pumps
- 10,500 km of large-diameter pipes
- 90 large earth reservoirs
- 750 concrete and steel reservoirs

Population Impacts on Israel's Water Resources

The population in Israel in 2013 was approximately 7,707,042. The graph below shows steep population increases since its beginning in 1949. Much of the population in Israel is concentrated near the center of the country around the West Bank, Tel Aviv, Ashdod and Jerusalem. The increasing population in Israel as well as the increasing populations in neighboring nations puts a large stress on the water resources in Israel. The population in the Gaza Strip was 1.657 million people as of 2011, which as previously mentioned, puts major pressure on the Costal Aquifer and leads to increased seawater intrusion from over pumping in this area. Urbanization is also a major problem to the water resources in Israel given that 91.9% of Israel's population lives in urban areas. According to USGS some of the negative effects of Urbanization on water quality include increased erosion and urban runoff, increased sedimentation, sewage overflows, increased levels of pesticides in the water, development of waterborne pathogens, and increased levels of nitrogen and phosphorous.



Population Since 1949[52]

Population Density in Israel[53]

Effects of Zionism on the Water Sector

Zionism played a key role in the Israeli water sector. Zionism is a religious view that many Israeli citizens hold and emphasizes national growth, with a major focus on agricultural development through the use of Israel's water resources.

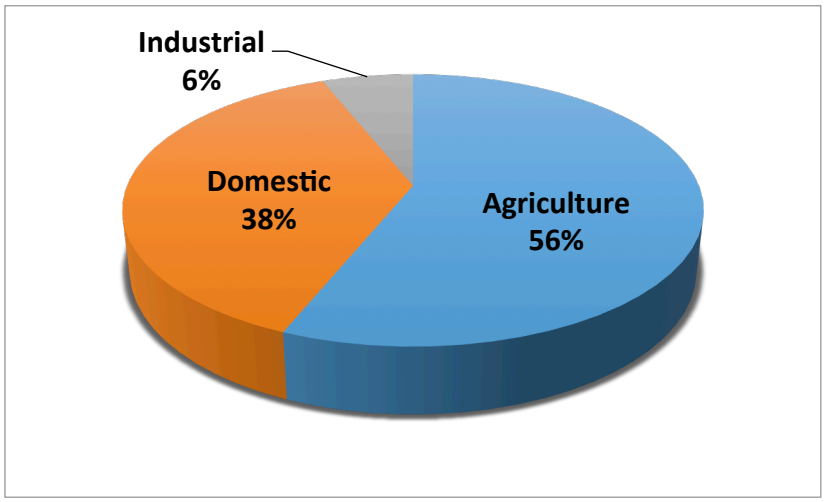
Water Demand

Water use in Israel is divided into three sectors: domestic, industrial and agricultural. Based on 2009 estimates of water use in Israel, the predominant consumer of water between the three sectors was the agricultural sector at 53.2% of total water use. The second greatest consumer of water is the domestic sector, using 35.8% of water resources, and the industrial sector made up the remaining 5.7% of total water consumed in Israel. In 2009, the agricultural sector consumed 1016 million cubic meters (MCM) of water per year, the domestic sector consumed 684 MCM per year and the industrial sector consumed 110 MCM per year. The average per capita domestic water use in Israel is approximately 137 liters per

[52] Population in Israel Since 1949. (n.d.). Retrieved from http://en.wikipedia.org/wiki/File%3APopulation_of_Israel_since_1949.svg

[53] Demographics of Israel. (2014, April 21). Retrieved from http://en.wikipedia.org/wiki/Demographics_of_Israel

day (Water Use by Sector, 2009)[54]. Based on these values the total water use in 2009 added up to approximately 1.81 billion cubic meters, 1.26 billion cubic meters of which was fresh water.



Water Supply

The long-term water availability in Israel is between 1.6 billion cubic meters per year to 2 billion cubic meters per year. The total water available between the years of 2008 and 2009 was much less than the historic average at 880 MCM per year.

Water Supply (in MCM per Year) between 1998 and 2020

Year	Population (Millions)	Surface Water	Ground Water	Brackish Water	Treated Effluents	Desalination	Total
1998	6	640	1050	140	260	10	2100
2010	7.4	645	1050	165	470	100	2430
2020	8.6	660	1075	180	565	200	2680

(Water in Israel, 2014)

[54] Water Use By Sector and Source. (2009). Retrieved from http://en.wikipedia.org/wiki/Water_supply_and_sanitation_in_Israel#cite_note-48

Water Demand (in MCM per Year) between 1998 and 2020

Year	Urban	Sector	Natural Effluents	Brackish	Wastewater	Total
1998	800	920	120	260	1300	2100
2005	980	750	95	380	1225	2430
2010	1060	680	75	490	1245	2680
2020	1330	600	60	640	1300	2680

(Water in Israel, 2014)

During times of severe and prolonged drought, the great magnitude of water deficiency must be overcome in order to preserve the available natural water sources and sustain the livelihoods of Israeli citizens.

Potable Water in Israel

The potable water in Israel comes from a variety of sources. The main surface water source that Israel receives their drinking water from is the Sea of Galilee, also known as Lake Kineret. Approximately 30% of the drinking water in Israel comes from Lake Kineret, amounting to about 242 MCM in 2006. The two main ground water sources that generate the most potable water for Israel are the coastal aquifer and the Mountain aquifer. According to data by Mekorot, the Coastal Aquifer and the Mountain aquifer supply approximately 36% of the potable water in Israel. Approximately 2,800 wells are located within these aquifers and between the two, 700 MCM of water are pumped from them each day. Of the 2800 wells in these aquifers, 150 of them act as recharge wells so that water will be replenished back into the system. Finally, natural springs supply the remaining 34% of the drinking water in Israel (Mekorot, n.d.).

Desalinization and reservoirs are also a major part of the sources of potable water in the country. In Israel there are currently 31 desalinization treatment plants, which together have a capacity of about 1 million cubic meters per day. Reservoirs are important for the collection of floodwater and groundwater recharge (Mekorot n.d.).

Current and Planned Seawater and Brackish Water Desalinization

Because of the major impacts of drought in the country and depletion of existing water resources, the government decided to approve the implementation of a series of seawater desalinization plants

located near the coast of the Mediterranean Sea. This was a significant development that was planned to supply the country with an additional 500 MCM of water by the year 2015 (Water Context 2008)[55]. Their goals, however, did not stop there. By 2020 Israel plans for their seawater desalinization plants to provide an additional supply of 750 MCM of water. During such severe droughts like the one that occurred between 2008 and 2009, this would be a sufficient amount of water to sustain the country. Great progress has already been made in developing seawater desalinization plants. By 2013 four plants were operational. Together these plants had a total capacity of 500 MCM per year, which was right in line with Israel's goals. These seawater desalinization plants use reverse osmosis technology and their power comes from self-generation.

The table below displays the existing seawater desalinization plants in Israel, their annual capacity and date of opening.

Date of opening (month/year)	Location	Capacity (MCM/year)
08/2005	Ashkelon[56]	111
05/2007	Palmachim[57]	45-90
12/2009	Hadera[58]	127
08/2013	Soreq[59]	75-150

An additional seawater desalinization plant is under construction in Ashdod with an anticipated capacity between 100-150 MCM per year.

At the time of its development in 2005, the seawater desalinization plant in Ashkelon was the largest sweater reverse osmosis desalinization plant in the world.

[55] Water Context 12/12. (2008). Retrieved from http://www.emwis-il.org/EN/Water_context/context_12.htm#Desalination
[56] Ashkelon, Israel. (n.d.). Retrieved from http://www.water-technology.net/projects/israel/
[57] Palmachim desalination plant inaugurates expansion - Globes English. (n.d.). Retrieved from http://www.globes.co.il/en/article-1000601526
[58] Funding agreed for expanding Hadera desalinization plant. (2009). Retrieved from http://en.wikipedia.org/wiki/Water_supply_and_sanitation_in_Israel#cite_note-39
[59] RSS. (n.d.). Retrieved from http://www.desalination.biz/about.asp?channel=0

Wastewater Treatment Plants

Treated wastewater also adds a significant portion of water in Israel. In 2010, about 4 MCM of treated wastewater was reused.

The Organizational Component Applied to Israel

Section description: *This component helps the user to understand the legal and institutional frameworks involved in the drought management planning process. It also helps to identify which drought mitigation tools and methodologies are most suitable for a specific the specific geographic location. Coordination with various institutions, compilation of societal responses to drought, and the provision of public information are also involved in this component*.

Legal framework

There are two main laws that are in place to regulate water resources in Israel. The first is the Water Law of 1959 and the second is the Water and Sewerage Corporations Law of 2001.

Water Law of 1959

The Law of 1959 was put forth by the government in order to manage the exploitation of water resources and to put in place a new framework for water allocation. The government placed the Water Commissioner in charge of implementing the new policy. It became the job of the Water commissioner to guarantee that the water resources in Israel meet water quality standards, while maintaining a sufficient amount of water availability in the country by practicing water conservation and preservation. The key purposes of the water law were to prevent pollution and influence conservation of water resources. This water law was significant in that it made water resources public property. The law states that all water resources in Israel are available to consumers, as directed by the Water Commissioner (Water in Israel 2014).

The government in Israel set forth a plan to better develop the water sector by 2010. Their plans involved the following:

- Construct desalinization plants that hold enough capacity to store 400 MCM of seawater per year and 50 MCM of brackish water per year.

- Rehabilitate those wells that are polluted and have suffered depletions in water levels. This restoration of wells should produce an extra 50 MCM per year.
- Import a quantity of 50 MCM of fresh water from Turkey annually.
- Make better usage of sewage effluents so that a greater portion is suitable for irrigation purposes. This step is proposed to save an annual 500 MCM of water (Water in Israel, 2014).

These plans set forth are designed to make up for the discrepancy between a supply shortage caused by over exploitation of Israel's natural water resources and Israel's demand for water. In order to achieve the goals listed above, the government will create a new water policy that ensures the stability of the water supply, considers social and economic requirements, and addresses the maintenance of ecological and environmental health. One of the main issues of the water law was that it involved too many government ministries, which hampered efficient management, planning and development. Because of the issues Israel encountered with the Water Law they created the Water Authority (Water in Israel 2014).

Water Sharing Agreements

Some notable cross-boundary agreements are the Oslo Accords and the Israel-Jordan Peace treaty. The Oslo I Accord, signed in 1993 allowed Palestine to use 52 MCM from the West Bank Mountain Aquifer per year. The Israel-Jordan peace treaty was signed in 1994 and gave Jordan rights to 50 MCM of water per year and 75% percent of the water in the Yarmouk River.

The Water Authority

In 2006 there was an amendment to the Water Law of 1959. This amendment resulted in the creation of a centralized body to handle water resource issues and was named the Governmental Authority of Water and Sewerage, but is more commonly known as the Water Authority. The water authority is made up of a variety of agencies and is headed by a council of high level officials and senior officers from the following ministries (Water in Israel, 2014):

- Ministry of Finance
- Ministry of Energy and Water
- Ministry of Environmental Protection
- Ministry of the Interior

The former role of Water Commissioner was revised and became the Director of the Water Authority. The Director of the Water Authority is a civil servant who is nominated by the Cabinet. The position lasts for a period of five years and reports to both the Minister Energy and Water and the Knesset, which is Israel's legislative branch.

The Water Authority is also made up of a Water Board comprised of government representatives and key public figures. The public component of the Water board consists of consumers, suppliers and producers of water. The Water Board has the power to advise the Water Authority about certain measures. Meir Ben Meir was the Director of the Water Authority between 1996 and 2000. Below are the Past and current Directors of the Water Authority in Israel (Water in Israel, 2014):

Director of Water Authority	Years
Meir Ben Meir	1996-2000
Shimon Tal	2001-2006
Uri Shani	2006-2011
Alexander Kushnir	2011-current

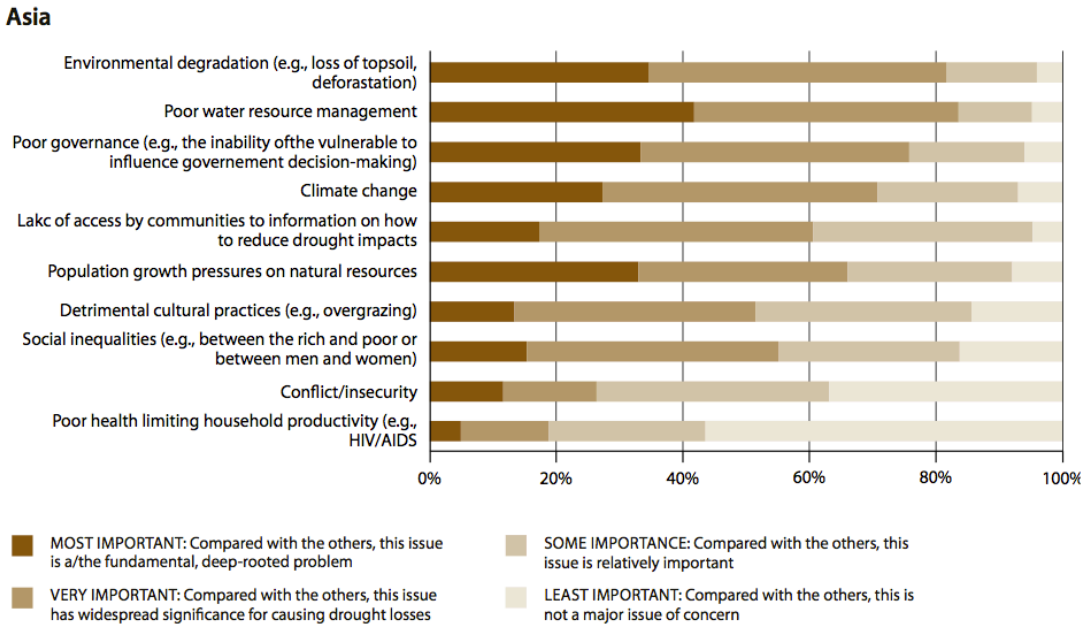
The Methodological Component Applied to Israel

Section Description: *The Methodological Component Involves developing the indicators of risk to drought and the compilation of scientific and technical approached to drought; defining methods to combat drought in the Mediterranean region; determining indicators of social vulnerability to drought based on academic methods; and developing technical studies in order to strengthen the use of indices when defining drought.*

Root Causes of Drought Impacts in the Region

According to the United Nations Development Programme's research on drought risk management, the main root causes of drought impacts in Asia are environmental degradation poor water resource management, and population growth adding pressure on natural resources (UNDP,

2012).[60] Israel has done a tremendous amount in their water resource management and is a world leader in desalinization and wastewater technologies. Unfortunately they are still affected by the potential poor water resource management in bordering nations. Population growth is very much an issue that increases the impacts of drought especially in those vulnerable areas around the West Bank and Gaza Strip. In the case of population growth, bordering nations also pose a potential problem to Israel because of the various transboundary water sharing agreements that are in place with Jordan and Palestine.



(UNDP, 2012)

Drought Vulnerability Index

Description of Vulnerability Index

The Primary method used by CIHEAM for assessing a country's vulnerability to drought is through their Drought Vulnerability Index[61]. The purpose of the index is to assess the level of risk that come from inadequacies in various socioeconomic areas such as technology, management, environmental, social and economic factors. The vulnerability index is broken up into six different categories: renewable natural capital, human and civic capital, institutional response, economic capacity, mechanisms of risk

[60] UNDP. (2012). Drought Risk Management: Practioner's Perspectives from Africa and Asia. Retrieved from http://www.unccd.int/Lists/SiteDocumentLibrary/Publications/Drought%20Risk%20Management%20-%20Practitioner's%20Perspectives%20from%20Africa%20and%20Asia.pdf

[61] Drought Management Guidelines. (n.d.). Retrieved from http://www.iamz.ciheam.org/medroplan/guidelines/methodological_vulnerability.html

sharing, and agricultural innovation (Drought Management Guidelines, n.d.). Based on the identified vulnerabilities, the drought vulnerability index should help to inform policy formation, policy decisions and mitigation actions to reduce risk and vulnerability. In this context risk refers to the probability of a hazard occurrence and vulnerability refers to the degree of loss resulting from a hazard occurrence. The Drought Vulnerability Index components and their corresponding indicators are listed in the table below.

Vulnerability Analysis

Each of the indicators within the vulnerability index has a target value. The target value can be a percentage, score, monetary amount or any other appropriate numerical value. These target scores were based on acceptable values compared to other nations around the world. Those values that fell below the target are considered areas of socioeconomic vulnerability in Israel and should be the focus when determining drought mitigation strategies and policy development.

Many of the indicators are scores ranging from 1-5, 1 being the poorest value. For example, under the institutional response component and in the indicators category, the strength of drought regulations was given the score of 1 out of 5. This low score is because of the lack of policies and laws that specifically address the issue of drought. This can be problematic if Israel wishes to combat drought on a more proactive, long-term basis. Conversely, Israel has very strong crop varieties and cultivation techniques and remarkably has been able to maintain very successful agricultural practices in one of the most drought-prone and arid regions of the world. Crop varieties received a score of 4 out 5 because they have a number of crops planted in the country, but should possibly consider incorporating more dry crops. The results if the drought vulnerability index are listed in the table below.

Drought Vulnerability Index Analysis and Results Table (Israel Demographics, 2013)[62]

Component	Indicators	Target	Israel's Value	Target Met? (yes/no)
Renewable Natural Capital	• Agricultural water use	30%	56%	NO
	• Precipitation	135 inches/year	65 inches/year	NO
	• Soil degradation	5%	N/A	N/A
	• Area salinized	5%	9.20%	NO
	• Population Density	280 inhab/km2	342.6 inhab/km2	NO
Human and Civic Capital	• Life expectancy at birth	70	81.17 years	YES
	• Literacy Rate	75%	97.10%	YES
	• Active population in Agriculture	5%	2.50%	YES
	• Population without sanitation water	5%	0%	YES
Institutional Response	• Strength of Drought regulations (1-5)	3.5	1	NO
	• Strength of Coordination among institutions (1-5)	3.5	2	NO
Economic Capacity	• GDP	$100 billion	$275.504 billion	YES
	• Population below poverty line	30%	23.60%	YES
	• Access to drinkable water	95%	100%	YES
Mechanisms of Risk Sharing	• Strength of Insurance (1-5)	3	3	YES
	• Strength of Agricultural policies (1-5)	3.5	4	YES
Agricultural Innovation	• Strength of Cultivation techniques (1-5)	3.5	3	YES
	• Crop varieties (1-5)	3.5	4	YES

Drought Vulnerability Index Results

Based on the drought vulnerability index, the areas that Israel are most vulnerable to drought are mostly within their renewable natural capital, which is to be expected due to Israel's arid climate, increasing population and over pumping in Israel's major water bodies. The areas in which Israel is most vulnerable include:

- Agricultural water use
- Precipitation
- Population density
- Area salinized
- Active population in agriculture
- Strength of drought regulations

[62] Israel Demographics Profile 2013. (n.d.). Retrieved from http://www.indexmundi.com/israel/demographics_profile.html

- Strength of coordination among institutions

These sensitive areas are highlighted in red in the table above.

Israel has a very strong economic capacity with a total GDP of 275.5 billion dollars and only 23% of the population lying underneath the poverty line. This means that they have the resources needed in order to utilize advanced and expensive technologies that will help them reduce the effects of drought. This is already seen in the areas of seawater and brackish water desalinization technologies. Israel's human capital is one of their strengths with 0% of the population without access to improved water sources, an extremely high literacy rate and long life expectancies. Other strengths that Israel possesses are its mechanisms for risk sharing. Over the years Israel policymakers have revised their agricultural policies and now much less water is allocated to the agricultural sector. This has resulted in increased water conservation.

The Operational Component Applied to Israel

Section Description: *The Operational Component includes early warning systems and preparedness measures; prioritizing efforts during drought and water scarce situations; determining social and physical thresholds as defined by drought indices; and defining and evaluating implementation of actions.*

The drought management strategies for Israel were developed based on lessons learned from Section 1 of this project, the analysis, mapping and identification of critical gaps in pre-impact and preparedness drought management in the Middle East; the legal, institutional, environmental, economic, social and geographical information gathered from the separate components of the CIHEAM drought management guidelines; the CIHEAM drought vulnerability index; and lessons learned from literature review concerning successful drought management in other arid countries around the world.

10-Step Drought Mitigation Planning Process

As a part of their drought management guidelines, CIHEAM supports a 10-step drought mitigation planning process proposed by The National Drought Mitigation Center Proposes. This 10-step process was initially formulated to address drought in the United States, but has successfully been applied to

other developed and developing nations. The drought planning process as proposed by NDMC is shown in the table below.

NDMC's 10-Step Drought Planning Process[63]

1.	Appoint a drought task force or committee
2.	State the purpose and objectives of the drought mitigation plan
3.	Seek stakeholder input and resolve conflicts
4.	Inventory resources and identify groups at risk
5.	Prepare and write drought mitigation plan
6.	Identify research needs and fulfill institutional gaps
7.	Integrate science and policy
8.	Publicize the drought mitigation plan and build awareness and consensus
9.	Develop education programs
10.	Evaluate and revise drought mitigation plans

It is recommended that Israel utilize this 10-step process when approaching drought management in Israel.

Recommendations

The strategies are divided into 6 categories: 1) Financial and Insurance Measures, 2) Agricultural Measures 3) Technological Measures 4) Water Conservation Options, 5) Legal and Transboundary Solutions, and 6) Capacity Building Opportunities. All of the strategies suggested are long-term measures designed to reduce the vulnerability to drought and mitigate drought proactively. For this reason, short-term, reactive measures are not emphasized in the recommendations.

Financial and Insurance Measures

1. Implement microfinancing opportunities for less advantaged groups and improved insurance prices.

[63] Wilhite D.A.,Knutson T.L. (2008). Drought Management Planning Conditions for Success. Retrieved from http://om.ciheam.org/om/pdf/a80/00800434.pdf

The Drought Vulnerability Index revealed that Israel has a very strong economic capacity and insurance systems in place. KANAT- Insurance Fund For Natural Risks in Agriculture is a major agricultural insurance provider in Israel. KANAT is headed by The Farmer's Marketing Boards and Organizations and Israel's government. Their services are intended to sustain and protect farmers' incomes during natural disasters such as droughts (KANAT, 2012)[64]. While there are insurance policies in place for stable actors in the agricultural sector, there are fewer insurance opportunities for more disadvantaged groups in the agricultural sector. The SAWA program is the first microfinancing program in Israel and was developed in San Francisco California in 2006 under the Koret Israel Economic Development Funds (KIEDF) (KIEDF, 2005)[65]. This is a developing sector and there is still a great need to implement microfinancing opportunities in Israel for the most disadvantaged groups.

2. Change water policies so that they reflect the true value of water, especially during drought.

Increasing water prices so that they reflect the true value of water will decrease the demand for water. This will be especially necessary during times of drought and water scarcity.

3. Remove any large subsidies given to sectors that use large amounts of water, like agricultural sector.

It is expected that the agricultural sector will receive subsidies within their insurance policies given the importance of the agricultural sector in the Israeli economy. Very large subsidies, however given to those sectors and industries that utilize a sizable amount of water should be limited in order to ensure that they are conserving water as much as possible.

4. Implement increasing block rate structure for water; higher prices associated with higher water usages.

Implementing a block rate structure for water use in Israel would result in higher water users paying more than those who use less water. This is also a strategy that will control the demand for water and most likely result in less water use by significant water users.

[64] KANAT. (2012). Retrieved from http://www.kanat.co.il/templates/kanat/images/KANAT2012.pdf
[65] Kiva Field Partner Koret Israel Economic Development Funds (KIEDF). (2005). Retrieved from http://www.kiva.org/partners/175

Agricultural Measures

1. Utilize advanced agricultural technology to diversify crops and begin to produce mainly drought resistant/sustainable crops as to not deplete soil; utilize more dry crops.

Israel has very advanced agricultural practices. They have been able to successfully produce a wide range of crops that provide the country with up to 75% of their domestic needs despite their arid land and frequent water scarce conditions. Their main crops include hay, chickpeas, beans, wheat, silage, legumes, cotton, and citrus fruits. The use of sand dunes and fertigation are often used for growing certain fruits like mango and citrus, which has been successful (Farming and Agriculture, 2013)[66]. Israel should consider diversifying their crops to incorporate more drought resistant crops so that their soil will not become depleted and so that they will be able to depend on agriculture as a major income generator in the future.

2. Engage in virtual water trading with countries with climates more suitable for agriculture.

Virtual water refers to the water that is embedded in certain crops or products. It relates to the amount of water needed to produce a product (Water Footprint, 2014)[67]. In this way, by importing crops from other countries that are more suitable for agriculture and have wetter climates, Israel can save its water for other important uses like the domestic sector and municipal water use.

3. Utilize Drip Irrigation

Drip irrigation is already a technique heavily used in Israel (Netanyahu Offers Israeli, 2014).[68] It entails water dripping slowly and directly onto the roots of plants. This way less water is needed for irrigation. It would be beneficial for Israel to make sustainable agricultural practices like drip irrigation agricultural standards through policies.

Technological Measures

1. Implementation of Early Warning Systems

As emphasized throughout this report, there is a great need for the utilization of early warning systems, especially in the Middle East. Israel is advanced in that they do have early warning technology in place.

[66] Farming & Agriculture. (2013). Retrieved from http://israelmybeloved.com/farming-agriculture/
[67] Water footprint assessment manual - the global standard. (2014). Retrieved from http://www.waterfootprint.org/?page=files/Publications
[68] Netanyahu Offers Israeli Know-How to Manage California Drought. (n.d.). Retrieved from http://www.businessweek.com/news/2014-03-05/netanyahu-offers-to-help-california-s-brown-deal-with-drought

Most of the early warning technology identified through research is intended to monitor leaks and not determine approaching drought. Drought early warning systems have proven successful in other arid counties and would be beneficial to Israel.

2. Greater focus on wastewater treatment and reuse; and explore alternatives to use treated wastewater for other purposes outside of the agricultural sector.

In Israel is estimated that 400 MCM of wastewater is treated and reused. Most of the treated wastewater is used for agricultural purposes (Arid Israel Recycles, 2010)[69]. The availability of technology to treat and reuse wastewater is one of Israel's strongest assets during drought. It is recommended that they continue to focus their efforts on reusing treated wastewater and find ways to use it for other purposes outside of the agricultural sector. For example, water for latrines or industrial purposes does not necessarily need to be potable and reclaimed wastewater can be used for these purposes.

3. Seawater and brackish water desalination

Because of the extreme amount of seawater intrusion from population growth and over pumping in the aquifers, seawater and brackish water desalinization is very important and is projected to generate an additional 500 MCM of water for Israel in a year (Water Context, 2008). As there is an increase in seawater desalination, brackish water desalination plants will become more important. Currently there are approximately 30 brackish water desalination plants operating in Israel that are responsible for desalinating about 30 MCM per year (Water Context, 2008).

4. Renovate and monitor old wastewater treatment plants for best efficiency

To avoid leakages and inefficient use, treatment facilities should be monitored and updated on a regular basis. In Israel there are approximately 120 wastewater treatment plants. This could amount to a lot of water loss if there are leaks in the system (Wastewater Wonders, 1995)[70].

[69] Arid Israel recycles waste water on grand scale. (2010, November 14). Retrieved from http://af.reuters.com/article/commoditiesNews/idAFLDE6A01DQ20101114?pageNumber=3&virtualBrandChannel=0&sp=true

[70] Wastewater wonders. (1995). Retrieved from http://www.jpost.com/Magazine/Features/Wastewater-wonders

5. Expand Soil Aquifer treatment (SAT)

Soil aquifer treatment is a technique in which wastewater that has been partially treated, infiltrates down through the soil and recharges the aquifer. Natural processes help to remove contaminants in the water and significantly improve water quality (FAO 4. Aquifer Recharge, n.d)[71]

Water Conservation Options

1. Utilization of Water-Sensitive Urban Design

WSUD is an engineering approach with incorporates stormwater, wastewater and groundwater into infrastructure designs in order to reduce environmental degradation. This is also intended to increase the aesthetic appeal of urban designs (BMT, 2009)[72]

2. Rainwater Harvesting

Rainwater harvesting refers to the technique in which rainwater is stored and reused for a variety of purpose including maintenance of livestock, irrigation and gardening. The rainwater is also potable and may be used as drinking water (Rain Water Harvesting, 2014)[73].

3. Water Recycling in Industries

Much of the water used in industries is clean water and is at drinking water standards. In many cases this is not necessary and resources are unnecessarily going into the treatment of water used for industrial purposes. Using recycled water in industries should conserve a large amount of water and allow make more potable water available for those sectors that need it the most.

Legal and Transboundary Solutions

1. Increased transparency in the Water Authority and greater coordination among various ministries

Increased transparency in the Water Authority and coordination among various ministries would help to ensure that the needs of all stakholders are being met and would reduce conflict within multiple sectors competing for the same scarce water sources.

[71] 4. Aquifer recharge with wastewater. (n.d.). Retrieved from http://www.fao.org/docrep/t0551e/t0551e06.htm
[72] BMT WBM. (2009). *Evaluating options for water sensitive urban design – a national guide: Prepared by the Joint Steering Committee for Water Sensitive Cities: In deliveriting Clause 92*
[73] Rainwater harvesting. (2014, April 21). Retrieved from http://en.wikipedia.org/wiki/Rainwater_harvesting

2. Creation of a Drought Steering Committee

Israel has made great strides in their legal and political approaches to water with the creation of a centralized body to address water issues through the Water Board. Israel, however, still lacks the presence of a committee specifically committed to drought. A Drought Steering Committee has proven to be successful in some Middle Eastern countries such as Iraq. This committee is intended to be even smaller and more focused than the Water Body so that more attention and resources can be given to drought given how frequently occurs in this region.

3. Create laws and policies that specifically address drought

Israel has laws related to water, such as the Water Law of 1959 and the Water and Sewerage Cooperation Law of 2001. While effective, neither of these laws address drought specifically. Creating a drought law or policy could be an effective way of conserving water, ensuring equitable allocation of water, and ensuring that water sources are not being depleted. It is important to have an actual law or policy so that regulations will have legal backing and stricter implications of being out of compliance.

4. Engage in transboundary water resource management and greater transboudary information sharing

Israel is a country that shares water bodies with a number of countries like Palestine, Jordan, Egypt and Syria. There must be coordination amongst these countries in order to ensure that no one country is depleting or contaminating water sources more than another. Key ministries that are responsible for water resources in their individual countries should increase the transparency of their plans and collaborate with ministries with bordering nations.

Capacity Building Opportunities

1. Information dissemination and raising awareness through television campaigns

In the past Israel used television campaigns to raise awareness and reduce water use. One campaign was entitled "Israel is Drying Out," headed by Israeli celebrity, Ninet Tayeb, and achieved success in reducing water use by 10%. Given the past success of Israel in this area, they should continue to use these campaigns as educational opportunities to raise awareness. (How Israel Beat the Drought, 2013)[74].

[74] How Israel beat the drought. (2013). Retrieved from http://www.timesofisrael.com/how-israel-beat-the-drought/

2. Continuing to build capacity of prominent stakeholders and decision makers through national and international workshops and trainings on climate change and drought

There has been an increased attendance at workshops for drought and water scarcity. In cooperation with CIHEAM, Mediterranean Drought Preparedness Mitigation and Planning (MEDROPLAN), often holds workshops to prepare nations for drought. The United Nations recently had a workshop in Zaragoza, Spain in which leaders from nations collaborated about drought management and were taught effective drought management techniques. Workshops like these are available and should be attended by decision makers and stakeholders to strengthen their capacities of the subject.

3. Educating the public about drought preparedness

In order for people to make behavioral changes, it is important for them to understand the severity of the situation, how it affects their lives, and what can be done. Local workshops and educational opportunities should be held for community members so that they can contribute to combating drought proactively.

The Public Review Component Applied to Israel

The purpose of the Public Review Component is to review and revise the four other components as necessary. This involves stakeholder dialogue, workshops, interviews, and questionnaires in order to receive feedback and update drought plans so that they will be most effective.[75]

Once drought management strategies are in order. The public should be able to review each of the other components within the CIHEAM Guidelines. The plans will be revised and reviewed regularly to adapt to current conditions and implement newer technology.

Discussion and Conclusion

Drought is a major threat to those people living in the arid and semi-arid regions of the world. This project was intended to determine the best possible strategies for proactive drought management in order to help sustain the livelihoods of those people living in these arid regions of the world. In the

[75] Drought Management Guidelines, European Commission-EuropeAid Co-operation Office, Euro-Mediterranean Regional Programme for Local Water Management (MEDA Water), Mediterranean Drought Preparedness and Mitigation Planning (MEDROPLAN)

Middle East, droughts occur very frequently. Responses to drought have tended to be reactive, and the drought management strategies in place are typically short-term and emphasize emergency relief measures. Middle Eastern countries are beginning to research ways in which they can combat drought proactively by implementing long-term drought management strategies that reduce vulnerability to drought. This project is an extension of the United Nations initiative to strengthen national capacities to mitigate drought and water scarcity in the Middle East and involves two separate sections. The first section is the analysis, mapping and identification of critical gaps in pre-impact and preparedness drought management in the Middle East; the second section is a case study of Israel in which CIHEAM Drought Management Guidelines were applied to the country.

The 10 pilot countries involved in this project -- Jordan, Syria, Lebanon, Yemen, Egypt, Sudan, Tunisia, Morocco, Algeria and Libya, helped to provide critical information about current drought management practices being implemented in their individual countries. Through their responses it was determined that many of these countries were lacking drought steering committees, early warning systems, insurance for their farmers, regular revision of drought management plans, and long-term drought management plans. This project helped to identify some of these capacity gaps and knowledge gaps. This was a very important first step into determining how Middle Eastern countries, and other countries located in arid regions can combat drought proactively. One of the major elements of a successful drought management plan, as determined by an in depth literature review, is the implementation of early warning systems. Early warning systems will help national planners, policymakers, and stakeholders prepare proactively and set forth measures to reduce drought impacts. Through early warning systems, planners can come up with drought classifications to determine the severity of drought based on drought indicators such as environmental and socioeconomic variables. Examples of drought classifications are advisory, alert, alarm and emergency. Other very important elements of a drought management plan include the availability of insurance for farmers and disadvantaged members of society through index based insurance and microfinancing opportunities, and the development of a centralized body made up of scientists and high level officials that are in charge of managing drought related issues.

The second section was the case study of Israel. CIHEAM Drought Management guidelines were applied to the country in order to determine the best mitigation strategies based on the environmental, political, and socioeconomic factors of the country. Lessons learned from Section 1 were also applied to

Israel. A Drought Vulnerability Index was used as the analysis to determine areas in which Israel was most vulnerable to drought. Results showed that Israel has a very strong human and civic capital and economic capacity, but is very vulnerable in the category of renewable natural resources. Drought management strategies that emphasized Israel's high economic capacity and advanced technological innovations were proposed, like the utilization of desalinization technologies and wastewater treatment and reuse. Other measures that were proposed included agricultural methods, political measures, financial and insurance measures for the disadvantaged, and capacity building opportunities to raise public awareness and eliminate knowledge gaps. All of the strategies proposed emphasized long-term drought management and were proactive in nature. Through this study, numerous positive drought management measures have been identified. If those countries in the most arid regions of the world start to focus on changing their policies and practices to emphasize preparedness, their livelihoods and environment will be sustained over a much longer time period. Although the Middle East faces challenges when it comes to drought and water scarcity, this project provides implementable drought risk reduction strategies that if implemented have the potential to lessen drought impacts in the future.

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